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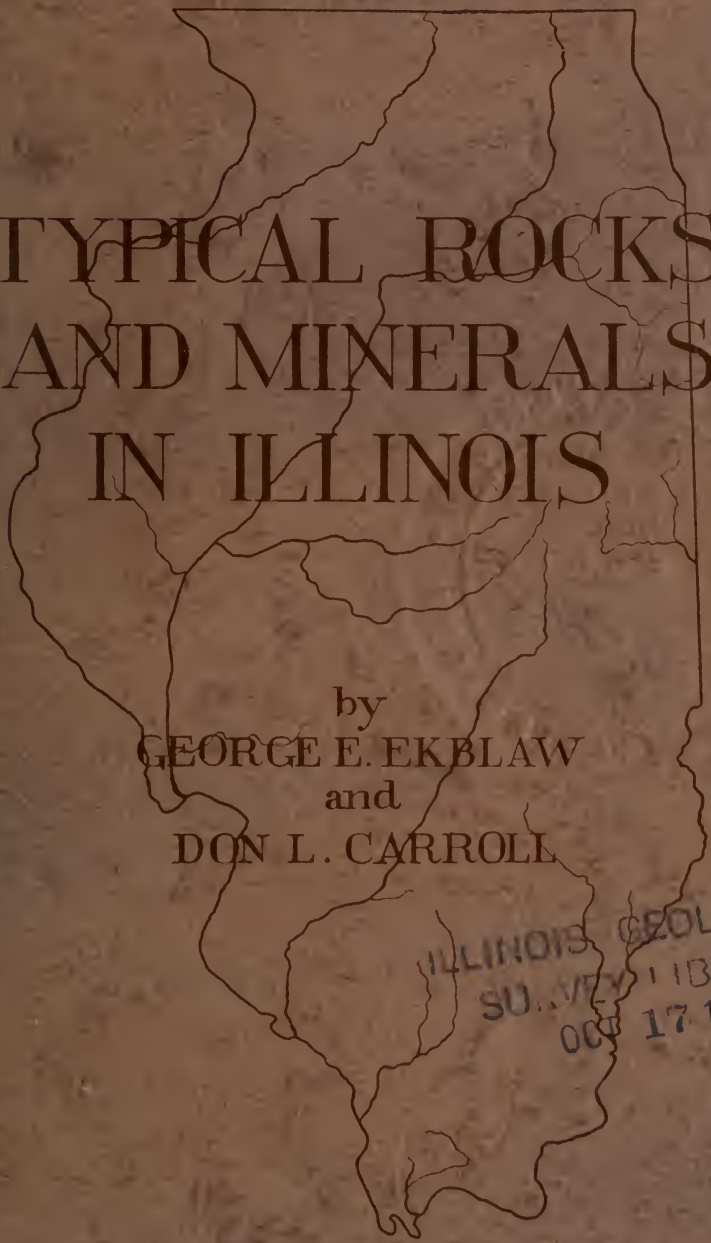
TYPICAL ROCKS AND MINERALS IN ILLINOIS



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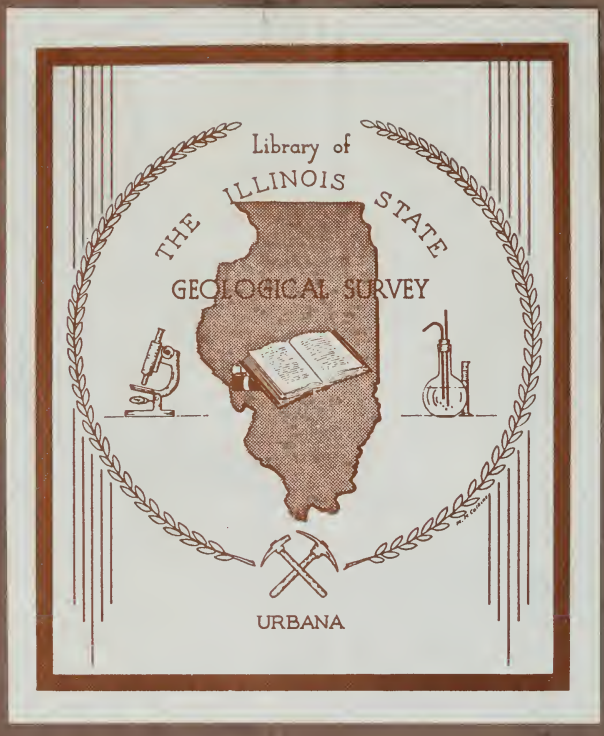

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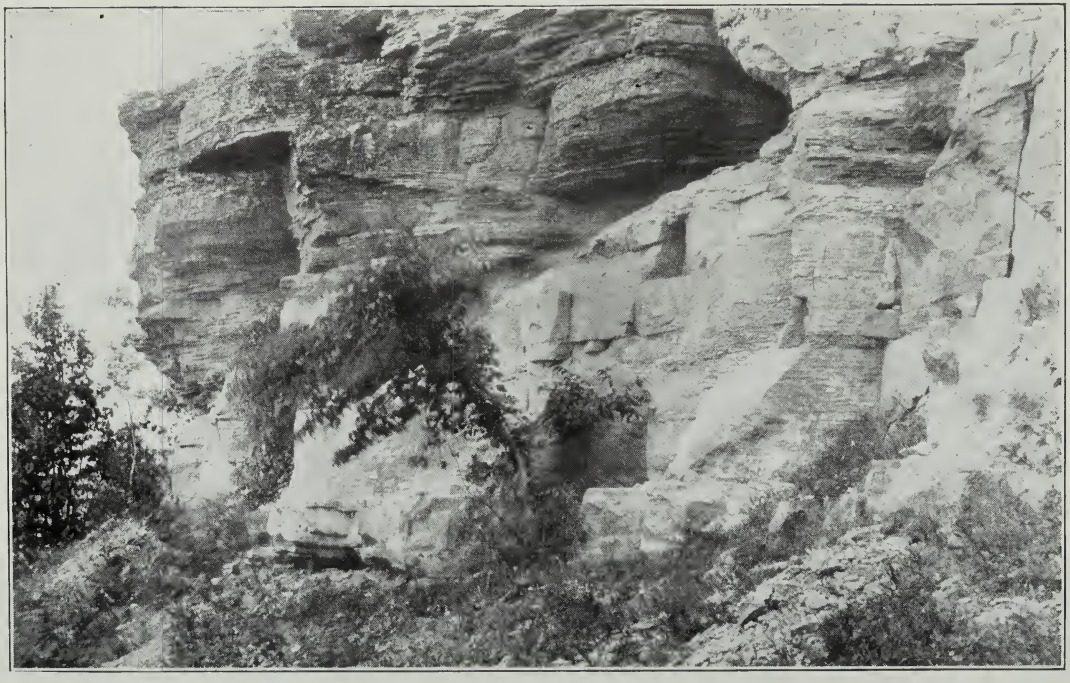

Massive dolomite (Niagaran formation) in northwestern Illinois. *Illinois State Geol. Survey Bulletin 26, plate 11-B.*

STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
STATE GEOLOGICAL SURVEY
M. M. LEIGHTON, *Chief*

EDUCATIONAL SERIES NO. 3

TYPICAL ROCKS AND MINERALS IN ILLINOIS

By

George E. Ekblaw and Don L. Carroll

Printed by authority of the State of Illinois

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Preface

In response to an increasing number of inquiries from schools and individuals for information regarding the rocks, minerals, and fossils of Illinois, this manual has been prepared to accompany sets of selected materials which the Illinois State Geological Survey is preparing for distribution to the public schools of the State. The manual is purposely brief, which necessitates the omission of much that might be said regarding these materials, but it is believed that this briefer form meets the needs of the public schools better than a more extended treatment.

The manual is so written that it is a source of much information without reference to the prepared sets of minerals, rocks, and fossils and will therefore answer many inquiries regarding the character of the minerals and rocks of Illinois.

This is the third of a series of educational pamphlets now being prepared by the State Geological Survey, the first two being "The Story of the Geologic Making of Southern Illinois" and "The Rock River Country of Northern Illinois." Others will follow.

M. M. Leighton, *Chief*

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FIG. 1. View of rugged topography in northwestern Illinois (Jo Daviess County). *Photograph by R. F. Flint.*

TYPICAL ROCKS AND MINERALS IN ILLINOIS

By

George E. Ekblaw and Don L. Carroll

INTRODUCTION

It is surprising how very little most of us know about the earth on which and from which we live. We accept as commonplace some of Nature's most remarkable manifestations, simply because they are so familiar, whereas there is actually underneath our feet and before our eyes a mystic earth world, if we will but pause and see it.

Illinois is often described as an area of monotonous, uninteresting flat prairies. It is regrettable that this opinion is so generally accepted, because in fact the greater part of the State is more or less rugged and displays intriguing as well as scenic prospects, and even the more flattish areas possess a wealth of interesting phenomena.

Doubtless at one time or another the curiosity of every person—man, woman, and child—has been aroused by some rock or mineral fragment or other item originating in the earth. In most cases their curiosity has remained unsatisfied because they could find no explanation for the object. For this reason this brief manual of rocks and minerals most commonly found in Illinois has been prepared with the hope that it may satisfy in part the curiosity aroused by their discovery and encourage further acquaintance with them.

For an adequate understanding of their occurrence, a brief resumé of the types of rocks and their origin is first presented, and the geological history represented by them is briefly summarized. The individual rocks and minerals are then discussed with reference to their character, their origin, their occurrence in the State, and their uses.

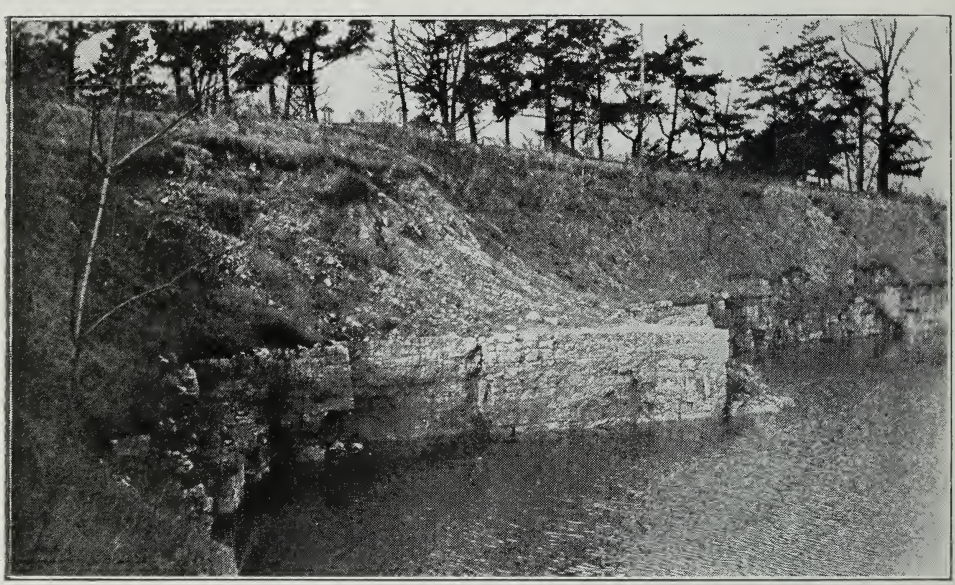

Fig. 2. Glacial till overlying limestone—an example of loose material over bedrock. *Illinois State Geol. Survey Bulletin 19, plate 11.*

CLASSES OF ROCKS

The rock materials of the earth may be conveniently classified as (1) loose, surficial material overlying bedrock (fig. 2), and (2) solid bedrock in place.

Surficial materials

The surficial material may be further classified as (1) residual deposits derived from other rock materials by weathering, (2) slope wash, landslide, and slump deposits, (3) alluvium or stream deposits in valleys, (4) lake deposits, (5) marsh deposits, (6) wind deposits, chiefly sand dunes and loess, and (7) glacial deposits. All of these deposits consist of sorted or unsorted material originally derived from bedrock and therefore contain fragments of many kinds of rocks and minerals. All of the State except the southernmost counties and probably Calhoun and Jo Daviess counties is covered with glacial deposits, designated collectively as *glacial drift,* which in turn is mantled with *loess* over most of the State.

GLACIAL DRIFT

During the Pleistocene period, the geologic period next preceding the Recent period, there were stages of long duration when the snow and rain that fell and froze as ice accumulated faster than it melted until in northern North America it became so thick that it spread outward, especially southward, from centers in Canada. The moving ice, or *glacier,* picked up and incorporated within itself some or all of the soil and surficial material over which it passed, and from the exposed bedrock it scraped and plucked fragments and masses of all sizes and description. These it carried with it, so that they were borne far from their original locality.

Eventually, probably due to climatic changes, melting balanced the advancing movement of the glacier, so that its margin remained relatively stationary for several sea-

sons. The material that it carried was released by the melting. Some of it was carried away by the water, from which the coarse gravel was dropped not far from the glacial margin, finer and finer material farther and farther away, and the finest clay was carried possibly all the way to the ocean. Much of the material in the glacier re-

FIG. 3. Glacial till accumulating at the margin of a glacier (Greenland). *Photograph by T. C. Chamberlin.*

mained where it was dropped as the ice melted (fig. 3); it formed a heterogeneous mixture of all sizes, from finest clay to the largest boulders, which is called *till*. Throughout the gravel and till are scattered a host of rocks, many of which have been carried from points far from Illinois and which are therefore of added interest.

As long as melting approximately balanced advance of the glacier, so that the margin of the glacier remained relatively stationary, the advance of the ice brought up

FIG. 4. Glacial moraine in Illinois, showing ridgelike development and typical irregular topography. *Photograph by W. C. Krumbein.*

FIG. 5. Typical kame near Elgin, Illinois. *Photograph by A. G. Kistler.*

more and more material as far as the margin and thus an irregular ridged belt of till, called a *moraine* (fig. 4), was there built up. Hills (*kames*) (fig. 5) and ridges (*eskers*) of gravelly material were built up where streams flowed in, under, or on top of the glacier or where they flowed out at the margin of the glacier. Further climatic change then halted all movement of the glacier or at least favored melting, so that the margin retreated and left a more or less undulatory till plain.

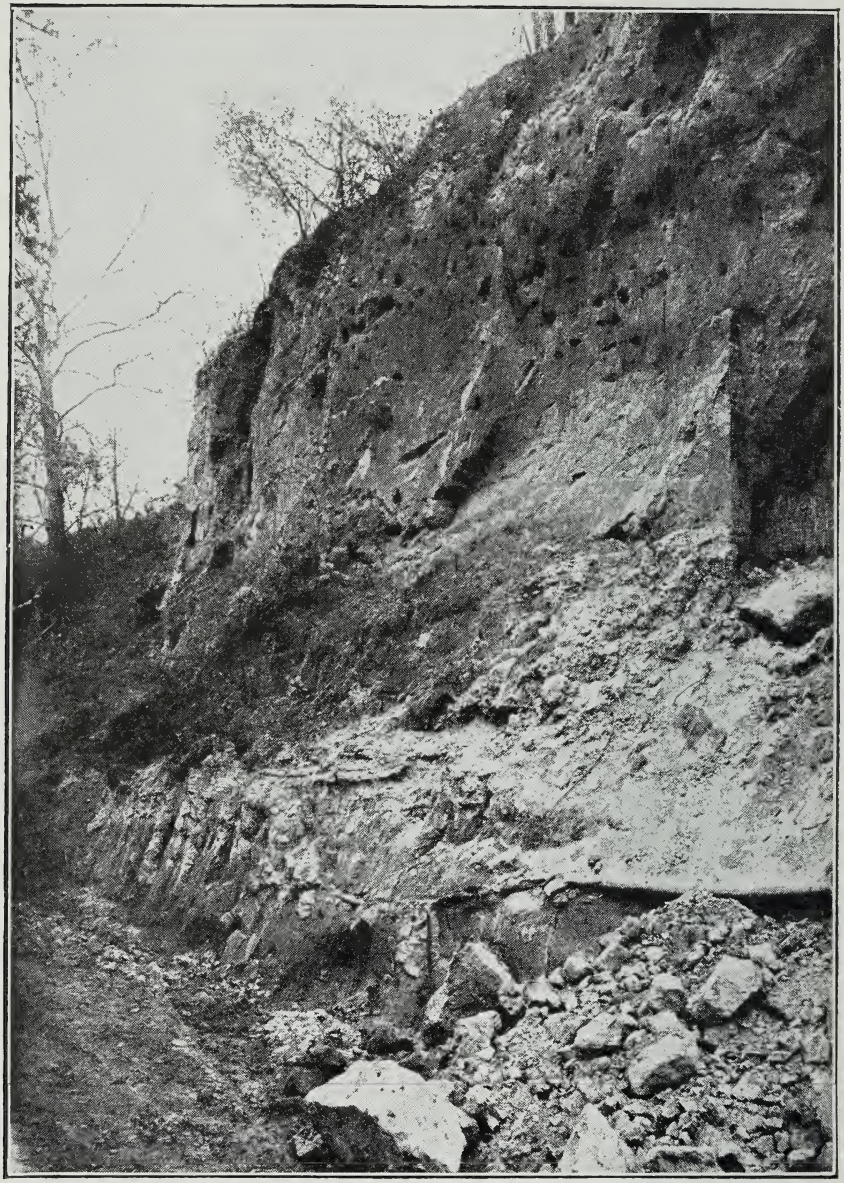

FIG. 6. Bluff of loess along Mississippi River, in Calhoun County, Illinois. Bank swallows find loess bluffs to be ideal nesting sites; note numerous nest-holes above. *Photograph by T. E. Savage.*

By means of old soils and peat deposits developed on one drift and then buried by another, as well as by other criteria, it has been determined that there were at least four distinct stages during which glaciers advanced over United States from Canada and retreated as warmer interglacial stages occurred. The alluvium and surficial deposits other than glacial drift, especially loess, which occur in Illinois were developed during the interglacial stages and since the last glacial stage.

LOESS

Loess is a powdery mixture of fine sand and silt which has been deposited by the wind during the Pleistocene and Recent periods. Most of it is believed to have been derived from silty material deposited by flooded streams flowing from the melting glacier. Whenever the flooded streams receded, the material they had deposited over their flood plains dried and the finer particles were picked up by the wind which carried them as dust and deposited them over the uplands. Consequently the coarsest material, in deposits of loess tens of feet thick, capable of standing in vertical bluffs (fig. 6), occur nearest large rivers like Mississippi and Illinois rivers, and finer material in deposits only a few feet or even a few inches thick occurs farther from them.

Originally the loess was calcareous, but since its deposition the upper part of it has been leached by ground water. The lime which the ground water leached from the upper part was carried downward and in many places was redeposited in the lower part, where it forms small more or less symmetrical irregular nodules. Many of

these nodules resemble grotesque figurines, hence they are called *"loess kindchen"* (German for "little children of the loess").

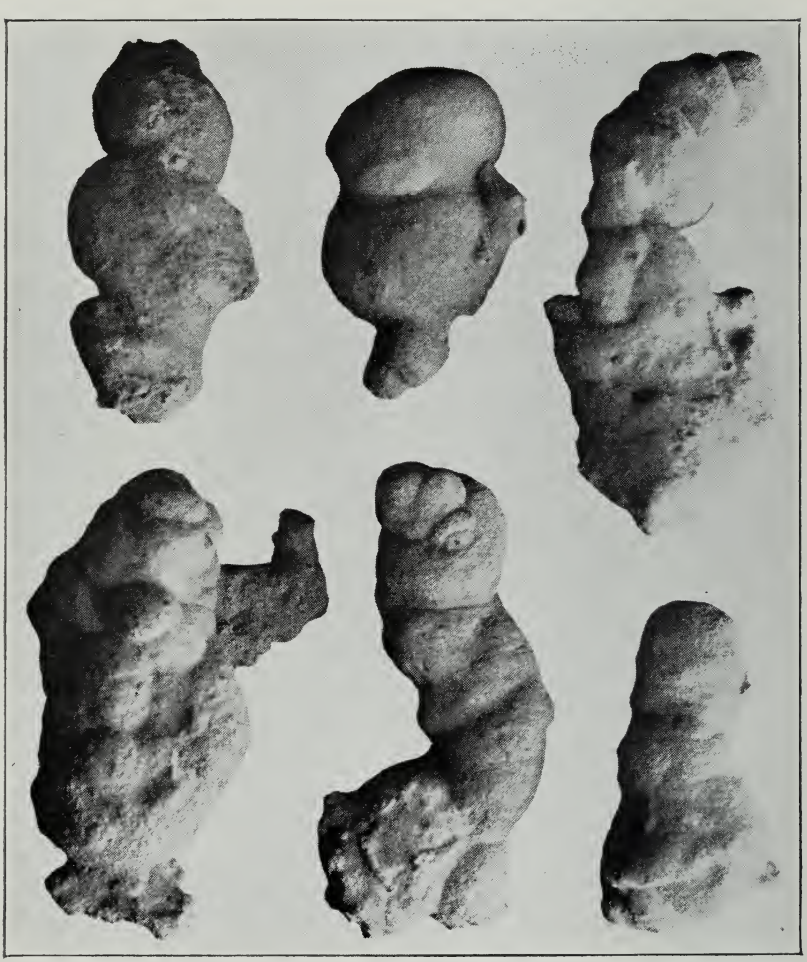

FIG. 7. Typical loess kindchen.

The high fertility of the soil of the Corn Belt in Illinois and other central states is due largely to the texture and chemical content of the loess and glacial drift which cover them.

Bedrock

The bedrock of the earth may be divided into three main classes—(1) igneous, (2) sedimentary, and (3) metamorphic rocks.

IGNEOUS ROCKS

The igneous rocks are classified as *intrusive and extrusive*. Intrusive rocks are those that were formed by the cooling and crystallization of molten rock *(magma)* forced into other rocks below the surface of the earth. Extrusive rocks are those that are formed by (a) the cooling and congealing of molten rock *(lava)* forced out on the surface of the earth or (b) the accumulation of rock ash and coarser fragments erupted by volcanoes. *Granite*, *syenite*, *dolerite*, and *peridotite* are common instrusive rocks; *basalt* and *felsite* are the most common lava rocks; and *tuff* and *pumice* are the most common volcanic rocks. Fragments of all of these kinds of rock, as well as many other igneous rocks foreign to the State, may be found scattered through the glacial drift or along the streams in Illinois. The only igneous rocks that are exposed in place in the State occur in Hardin County and in some coal mines in southern Illinois.

SEDIMENTARY ROCKS

As their name implies, the sedimentary rocks were formed by the consolidation of sediments deposited principally in the ocean, although some of them were deposited in lakes, along stream valleys, or on ancient land surfaces. The sediments consist (1) of rock waste derived by weathering of rock materials on the old land surfaces and (2) of chemical precipitates or organic secretions, or

both, from the water bodies. The principal sedimentary rocks are *limestone, dolomite, shale, siltstone, sandstone,* and *conglomerate.* In addition to these, there are several less important varieties and also all grades of transitional varieties, so that there are shaly limestones and limy shales, shaly sandstones and sandy shales, and so on. Fossils are frequently found in the rocks; they are the petrified remains of animals and plants and other evidences, including tracks, imprints, etc., of their existence at the time the sediments were deposited. As these sediments were deposited generally in water, the resulting rocks were originally almost or quite flat-lying, but as a result of the earth movements which later affected them they are tilted more or less steeply at some places. Sedimentary rocks are exposed in nearly every county of the State.

METAMORPHIC ROCKS

Metamorphic rocks, as their name signifies, are igneous or sedimentary rocks that have been considerably changed in various ways. No metamorphic rocks of consequence are exposed in Illinois, but fragments of various kinds may be found in the glacial drift and along streams. The most common varieties are quartzite (altered sandstone), gneiss and schist (altered igneous rocks), slate (altered shale), and marble (altered limestone).

GEOLOGICAL HISTORY

By records of wells that have been drilled deep into the earth's surface and by outcrops of rock in Illinois and adjacent states, it is known that at a depth of not more than a few thousand feet the State is underlain by an unknown thickness of igneous and metamorphic rock. By the same means it is known that this foundation of igneous and metamorphic rock is overlain by a series of sedimentary rocks that occur in regular sequence but may vary in thickness and in character. The sedimentary rocks are so generally mantled with glacial drift and other surficial deposits that they are exposed only in limited areas in the State.

The long history of the earth is divided into five great eras—Archeozoic (ancient life), Proterozoic (dawn of life), Paleozoic (early life), Mesozoic (middle life), and Cenozoic (recent life)—which extend backward millions and millions of years. The igneous and metamorphic rocks composing the rock foundation of the State belong to the Archeozoic and Proterozoic eras, the sedimentary rocks belong to the Paleozoic era, and the glacial drift and other unconsolidated deposits belong to the Cenozoic era. No rocks belonging to the Mesozoic era occur in Illinois. Each era is further subdivided into periods. For instance, the Paleozoic era is subdivided into Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and Permian periods, the names for each being derived from some region in Great Britain or in United States where the rocks are thick and well exposed. The rocks belonging to each period are divided into formations that persist over extensive areas. Each formation is designated by a name derived from some

locality where it is well exposed and each formation possesses typical characteristics—for instance, there is the St. Peter sandstone (St. Peters River, Minnesota), the Galena dolomite (Galena, Illinois), the Niagaran dolomite (Niagara Falls, New York), the Maquoketa shale (Maquoketa River, Iowa), etc.

TABLE OF GEOLOGIC TIME DIVISIONS

Era	Period	Dominant forms of Life[a]
Cenozoic	*Recent	Man
	*Pleistocene	
	*Pliocene	Warm blooded animals and flowering plants.
	Miocene	
	Oligocene	
	*Eocene	
Mesozoic	*Cretaceous	Reptiles, first flowering plants.
	Comanchean	
	Jurassic	Reptiles, medieval plants, and first birds.
	Triassic	
Paleozoic	Permian	Earliest land animals, first insects, and widespread forests.
	*Pennsylvanian (Coal Measures)	
	*Mississippian	
	*Devonian	Fishes and first forests.
	*Silurian	Shelled invertebrates, first fishes and first land plants.
	*Ordovician	
	*Cambrian	
Proterozoic	Keweenawan	Primitive invertebrates (without shells).
	Huronian	
Archeozoic		Most primitive, minute, and soft-tissued forms.

* Represented by rock formations in Illinois.

[a] After Pirsson and Schuchert.

A study of the rocks provides an interpretation of the general situation in which they were formed, and a reconstruction of at least the major events that comprise the geologic history of the State. Each formation represents a stage of time when this region was submerged beneath the sea and each break between formations represents an interval when the region was exposed as land. During the stages of submergence, mud or clay, sand,

FIG. 8. Typical unconformity between limestone dipping slightly to the right and shale dipping slightly to the left. *Courtesy New York Museum, Albany.*

gravel, marl, etc., were deposited and were later consolidated into shale, sandstone, conglomerate, limestone, etc. During the stages of emergence, the exposed land surface suffered erosion and weathering much as it does at present. When the region was resubmerged after each interval of emergence, the sediments deposited in the sea buried the irregular surface created by erosion and weathering, and so preserved the surface as an *unconformity* (fig. 8).

At various times the region was also affected by earth movements, by which some portions of the area were raised higher than others and as a result of which the original flat-lying rock strata were *faulted,* (broken) *folded,* or *tilted* so that in places they now dip more or less steeply.

After long periods of time, during which the region was alternately below and above the level of the sea, it was affected by the repeated glaciations, each of which left drift and related deposits. Following each glaciation, the surface was modified by erosion and the drift was affected by weathering, so that the surface relief—streams, rivers, lakes, valleys, ridges, plains, dunes, etc.—and the soil that now exist in the State were developed.

MINERALS AND ROCKS DESCRIBED

A *rock* may be defined as any considerable amount of mineral matter brought together by natural means. It may be loose or solid and may be composed of one or more minerals. A *mineral* is a body or mass of material,

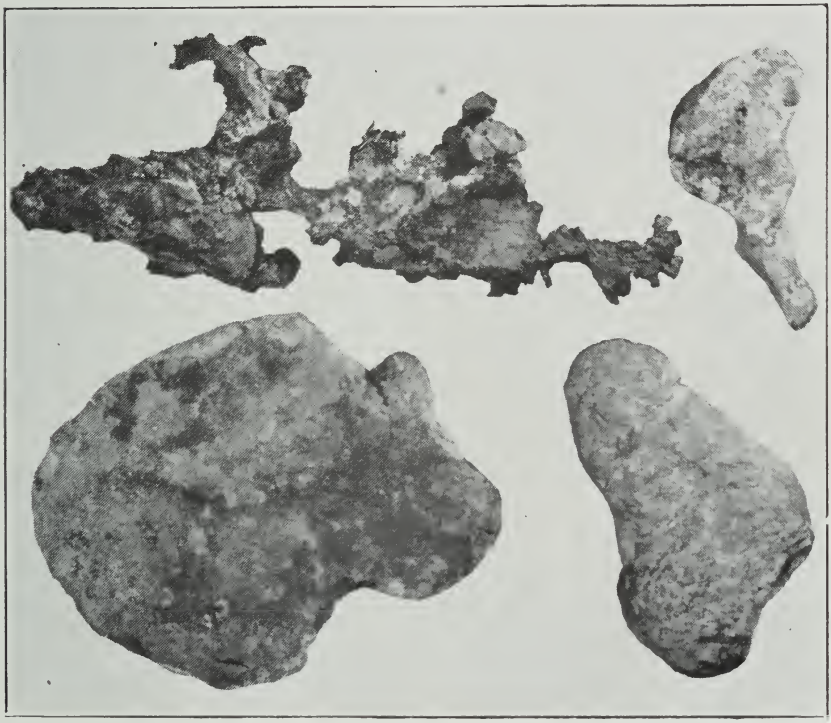

FIG. 9. Typical examples of copper nuggets found in the glacial drift in Illinois (p. 28).

usually solid, produced by inorganic processes and having definite chemical composition, typical crystal form and habits under favorable conditions, and definite physical properties, such as color, luster, transparency, hardness, toughness, fracture, cleavage, specific gravity, and many others.

Minerals

More than 1000 distinct minerals and innumerable varieties of them have been identified from all parts of the world, but only about fifty of them are very common. Only those minerals which possess outstanding characteristics and which occur in individual crystals so large, so commonly, or so typically in Illinois that they attract general attention are treated in this manual. Others worthy of mention are the hornblende and pyroxene groups of greenish-black minerals which are common in igneous rocks; barite and siderite which are occasionally found in sedimentary rocks; hematite, a reddish-brown iron-bearing mineral which occurs in Illinois mainly in a thin bed of unique material in the northeast part of the State; melanterite, a yellowish-white incrustation on pyrite or in rocks containing pyrite, especially those associated with coal beds; and copper which occurs as nuggets (fig. 9) in glacial drift.

Calcite, one of the most common rock minerals, consists of calcium carbonate ($CaCO_3$), which may be represented as a combination of lime (CaO) and carbon dioxide (CO_2). The pure mineral is white or colorless and transparent, but many specimens are yellowish or grayish-white and opaque as a result of impurities. Calcite can be easily scratched with a knife and usually can be easily split into perfect rhombohedrons. It effervesces readily when treated with hydrochloric (muriatic) acid (HCl). It possesses in a marked degree the peculiar property known as double refraction, as a result of which, for instance, a dot on a piece of paper viewed through a piece of transparent calcite appears as two dots, and if the calcite is rotated, one dot appears to move around the other.

Calcite is the principal constituent of all limestones and marbles, the major component of dolomite, and a lesser component of other sedimentary and igneous rocks. It commonly forms the stalagmites and stalactites found in caves, fills cavities and crevices in the rocks, and in the

FIG. 10. Group of calcite crystals. *Courtesy Illinois State Museum, Springfield.*

variety known as **travertine** occurs as a surface deposit associated with ground water seeps, springs, and geysers. Although it is found in one form or another in most parts of Illinois, the mineral itself is but little used, small amounts of it being ground for agricultural lime in southern Illinois.

Feldspar is a general name for a large group of minerals all of which are aluminum silicates of sodium, potassium, and calcium and consist of silica (SiO_2) and

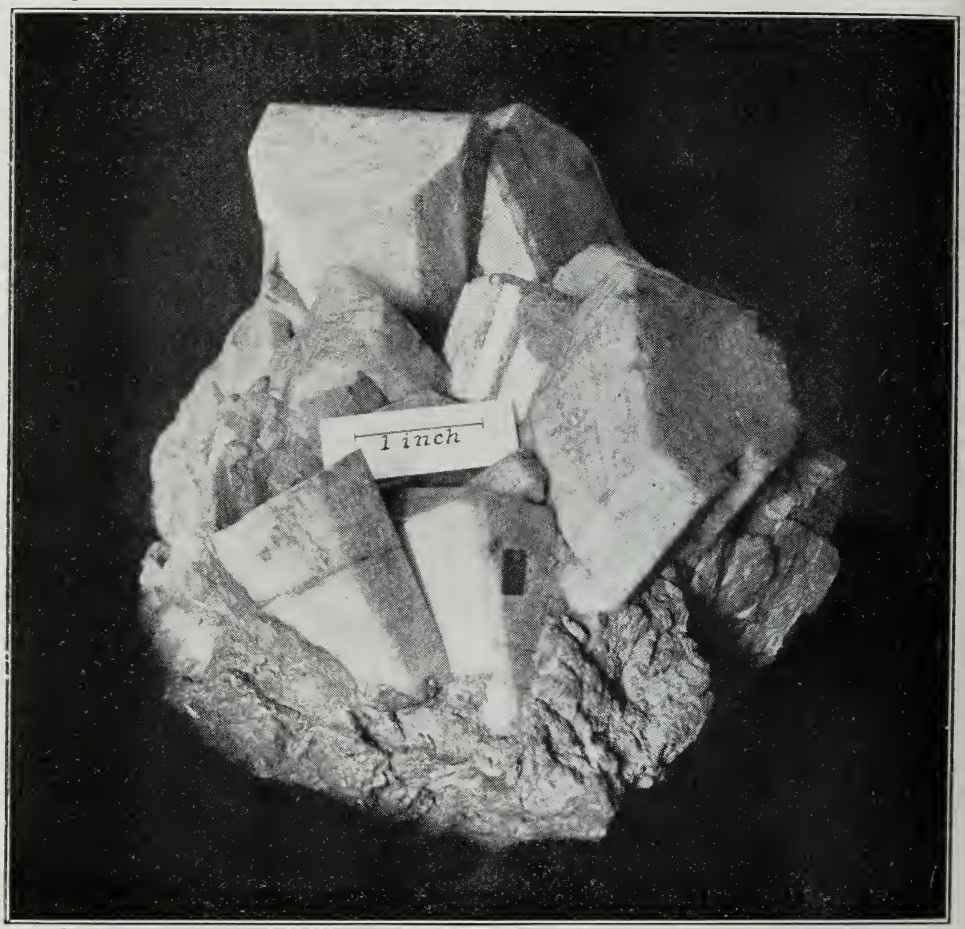

FIG. 11. Group of feldspar crystals. *Courtesy Illinois State Museum, Springfield.*

alumina (Al_2O_3) with varying amounts of soda (NaO), potash (K_2O), lime (CaO), and other elements. Feldspar is brittle and hard enough to scratch soft glass. It has

a pearly or vitreous luster and is white, gray, pink, red, yellow, and blue in color. It is a common mineral in igneous and metamorphic rocks and hardly occurs otherwise in Illinois.

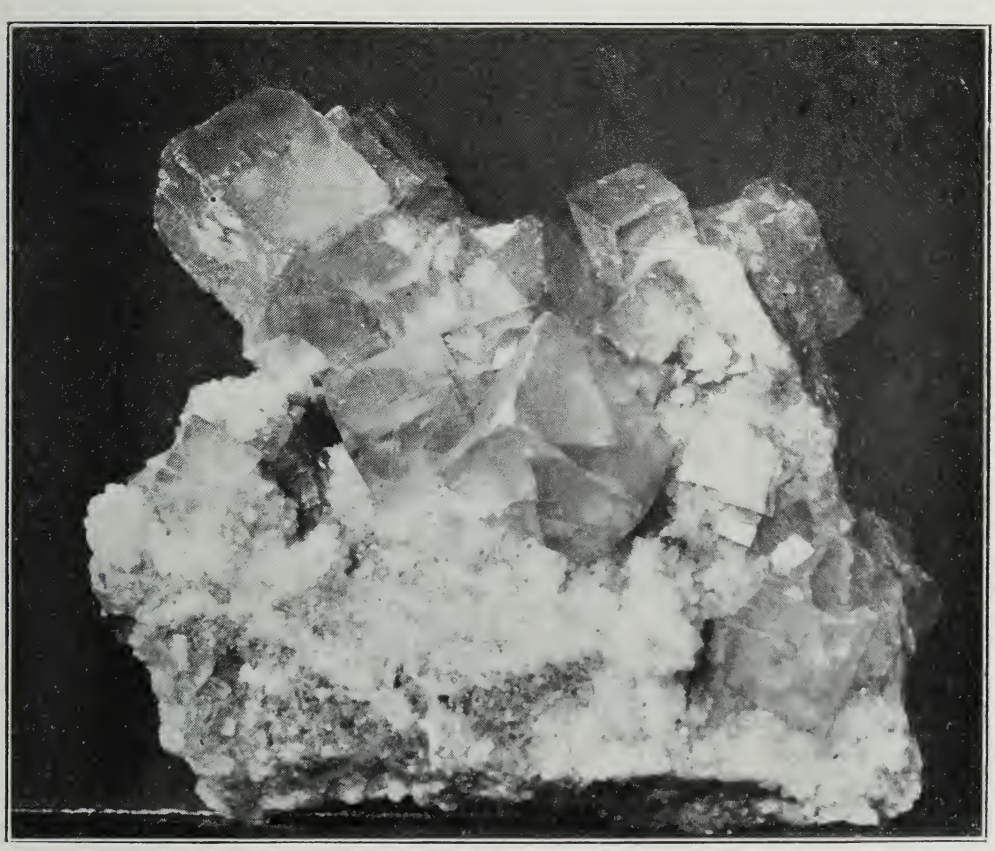

FIG. 12. Group of fluorite crystals. *Courtesy Illinois State Museum, Springfield.*

Fluorite (fluorspar), probably the most important commercial mineral in Illinois, consists of calcium fluoride (CaF_2). It is colorless, white, amber, yellow, green, blue, or purple and has a glassy luster. It can be scratched with a knife and can be easily split into octahedrons. Crystals of it are cubical in shape.

Very extensive and valuable deposits of fluorspar occur in Hardin and Pope counties, in southeastern Illinois. The mineral is there found in vertical or nearly vertical veins 5 to 15 feet wide or in horizontal beds in some of the limestone formations and is mined to a depth of 600 feet.

Most of the fluorspar is used in the manufacture of basic open-hearth steel, small amounts are used by the ceramic and chemical industries, and clear transparent fluorite is used for making certain kinds of lenses for microscopes and small telescopes. More than 50,000 tons of fluorspar, worth more than a million dollars, are produced each year in southeastern Illinois.

Galena, lead sulfide (PbS), is the principal ore of lead. It is heavy, opaque, bright lead-gray in color and of metallic luster when fresh, and can be scratched with a knife. It occurs in cubical crystals and readily breaks into cubical fragments.

FIG. 13. A group of galena crystals.

Small crystals or masses of galena are found in limestone formations in many places in Illinois. In northwestern Illinois the mineral was once sufficiently abundant to warrant mining on a scale that made the region the world's greatest source of lead at the time. In southeastern Illinois it is associated with fluorite where it is recovered as a by-product of fluorspar mining.

Gypsum, hydrous calcium sulfate ($CaSO_4+2H_2O$), is a white, transparent to opaque mineral when pure but often possesses various colors—yellow, red, brown, blue, gray, and black—as a result of impurities. It is so soft that it can be easily scratched with the fingernail and it splits readily into thin sheets which are only slightly

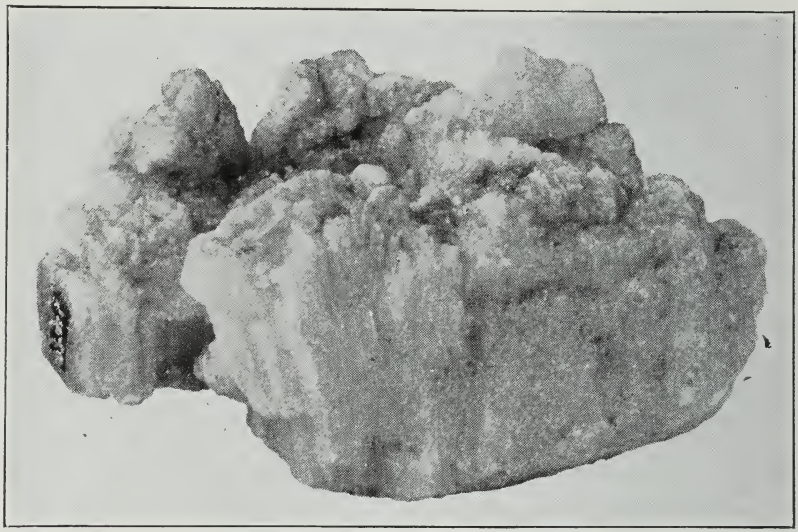

Fig. 14. Fibrous gypsum.

flexible. In this respect it differs from mica which is flexible. It is softer than calcite and quartz which minerals it otherwise resembles.

In Illinois gypsum is found as thin layers, as small platy or fibrous crystals, or as small aggregates along joints, in cavities, or scattered through shales and clays. Because it occurs only in small quantities it is of no commercial importance in this State but elsewhere huge deposits of gypsum are the source of material for making plaster, building materials, plaster of Paris, and many other products.

Limonite is a hydrous iron oxide ($2F_2O_3+3H_2O$), yellow, rusty, reddish-brown, or black in color with a characteristic yellow streak. It occurs commonly and in a variety of ways, mainly as stains or cementing material in soil, clay, sand, gravel, and rocks, as thin sheets and coatings in crevices, as "buckshot" in some soils, as irregu-

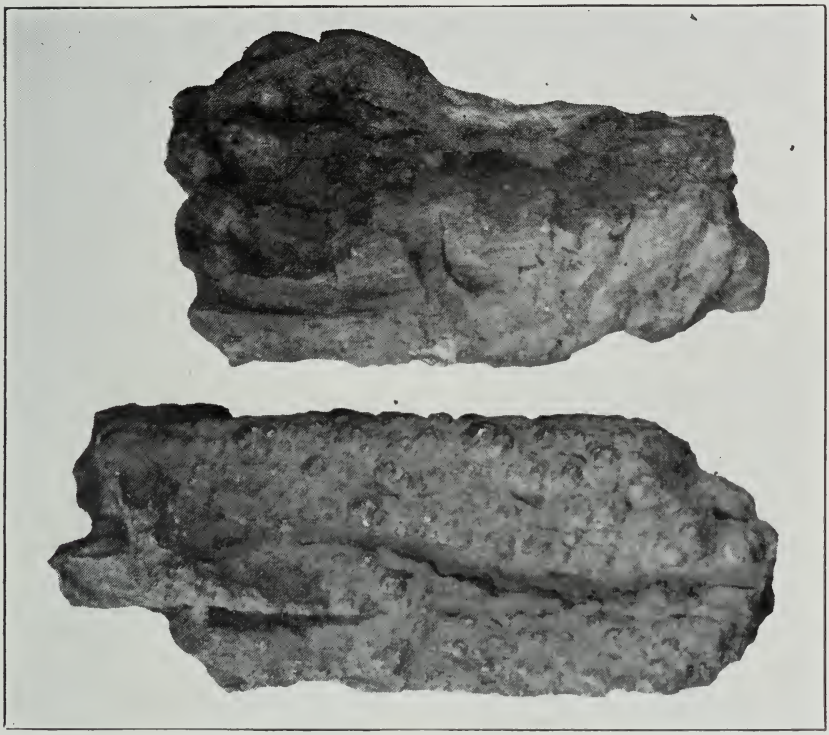

Fig. 15. Limonite.

lar aggregates or accumulations in loose material or in cavities in rocks, as tube-like accumulations around plant roots in soil and loose rock material, as oily scum or greasy stain on stagnant water or on rocks over which iron-bearing water flows, as "bog-ore" in swamps and marshes, etc. It is the mineral that gives the color to ocher but otherwise is of no commercial importance in Illinois at present.

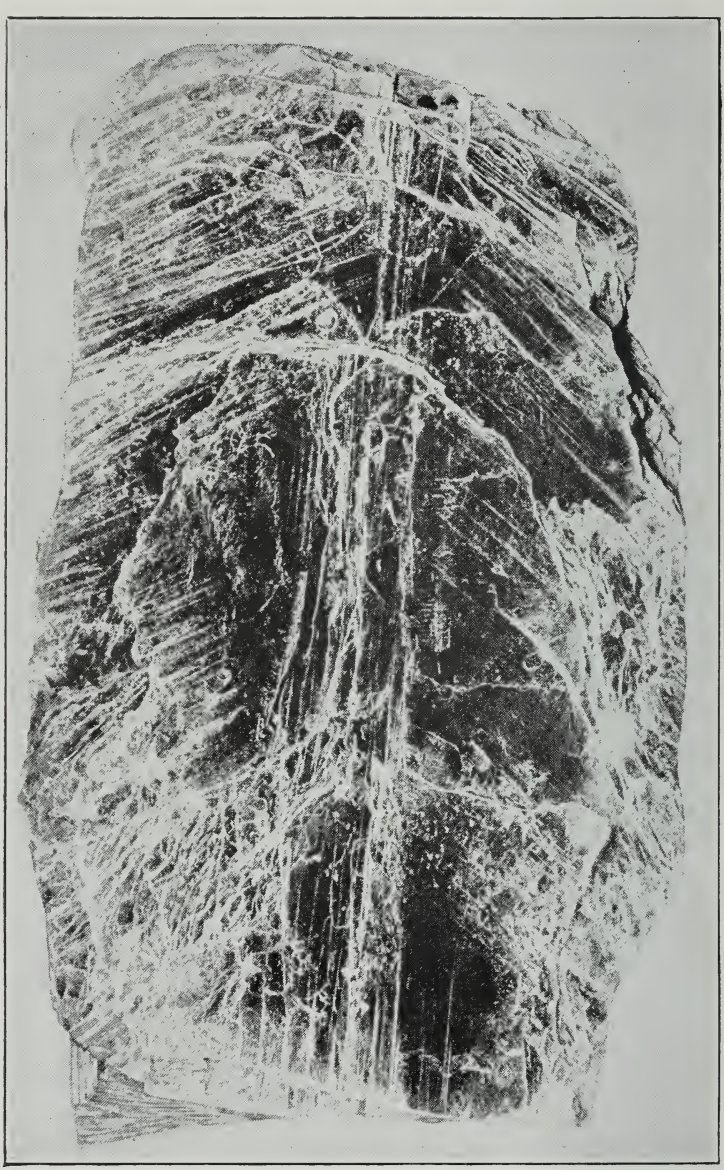

FIG. 16. A piece of mica showing the edges of thin sheets into which it is readily split. *Courtesy U. S. Geological Survey.*

Mica is a mineral of complex chemical composition which is characterized by its ability to be split into thin flexible sheets. The large plates derived from well developed crystals are commonly known as isinglass. Mica is more or less transparent and relatively soft, as it can be scratched with the fingernail. Its color depends on the constituent elements. The common varieties of mica found in Illinois are white, brown, or yellow. The shining flakes of these last two varieties are often mistaken for gold but may readily be distinguished from it by the fact that they are much lighter in weight and can not be beaten into thin sheets as can gold.

Mica is a very common constituent of nearly all igneous and metamorphic rocks and occurs commonly in sandstones. The surfaces of the plates reflect light so perfectly that they are conspicuous and so attract more than usual attention. Where it occurs in large amounts it is commercially valuable for insulating materials, but in Illinois it is found only as small flakes scattered through sands and sandstone or as small crystals in boulders of igneous and metamorphic rocks.

Pyrite, iron sulfide (FeS_2), is a brassy-yellow mineral well known as "fool's gold" because its color resembles that of gold, from which it may be distinguished by the fact that it crushes to a powder whereas gold is malleable and forms a thin leaf when beaten.

Pyrite occurs in either crystalline or massive form, as grains, as small or large masses, and as veinlets in all kinds of rocks. In Illinois it is found in appreciable amounts only in association with coal beds. During the

World War the pyrite encountered in coal mining was separated and used for the manufacture of sulfuric acid, but since then this production has been practically aban-

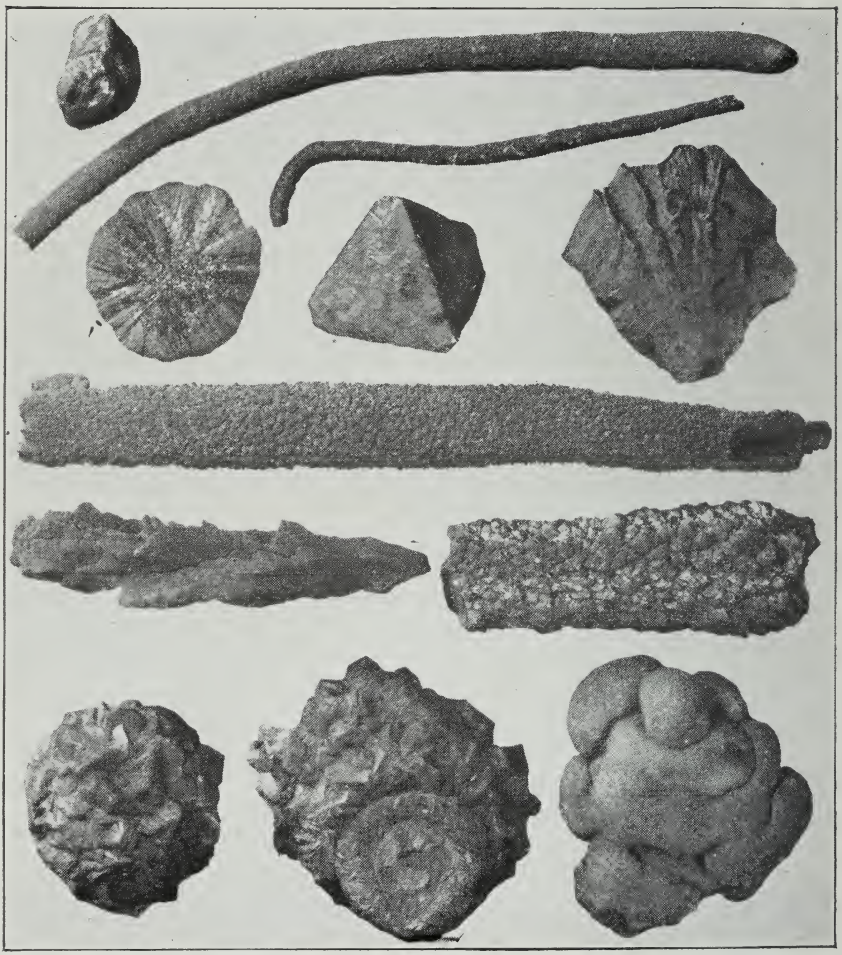

FIG. 17. Pyrite and marcasite in various forms found in Illinois.

doned because pyrite is of possible commercial importance only when present in large quantities. **Marcasite** is very similar to pyrite and is frequently confused with it.

Quartz, silicon dioxide (SiO_2), is probably the most common mineral in Illinois. When pure it is colorless and transparent, and looks like glass. It frequently occurs in well developed crystals, when it is commonly known as

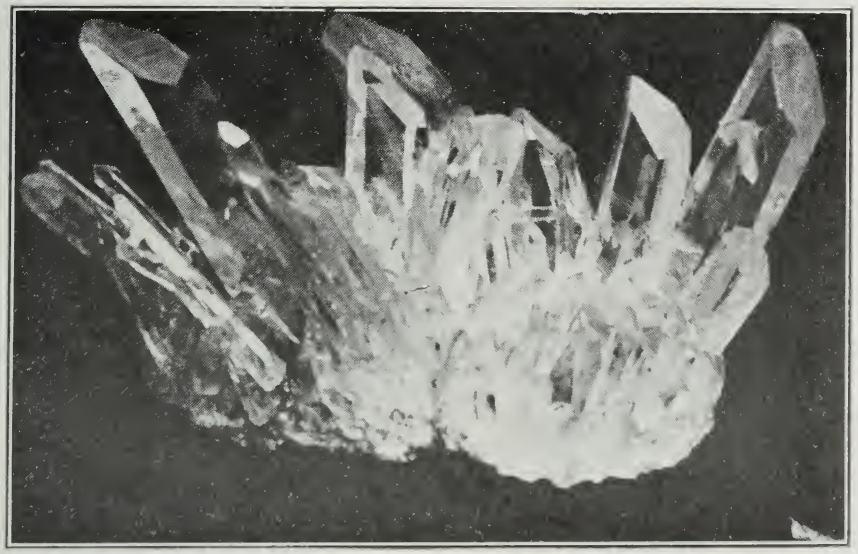

FIG. 18. A group of quartz crystals. *Courtesy W. S. Bayley.*

rock crystal. Impure varieties are tinted various colors—pink, red, orange, yellow, green, blue, purple, violet, gray and black—and may be given special names. Most common in Illinois are the rock crystal, the white "milky" quartz, and the gray "smoky" quartz. Quartz also occurs in dense, opaque forms, known as chalcedony, agate, onyx, chert or flint, jasper, etc. Some of the special colored and the clear crystalline varieties of quartz are used for gems, as amythyst, false topaz, bloodstone, carnelian, sardonyx. Quartz is brittle and very hard, scratching glass readily. It is the hardest mineral described in this manual and will scratch any of the other minerals mentioned. It is often mistaken for but is softer than diamond.

Quartz comprises the mass of common sands, sandstones, and quartzites and is an essential component of many igneous rocks, especially granites and diorites, and many metamorphic rocks. It also occurs commonly as veins, geodes, and chert nodules in all rocks.

Sphalerite, zinc sulfide (ZnS), well known among miners as "black jack," is the principal ore of zinc. It is semi-transparent and usually yellowish-brown, reddish-brown, or black, but it may be colorless, white, or yellow. It is heavy, platy, and brittle, has a resinous luster, and

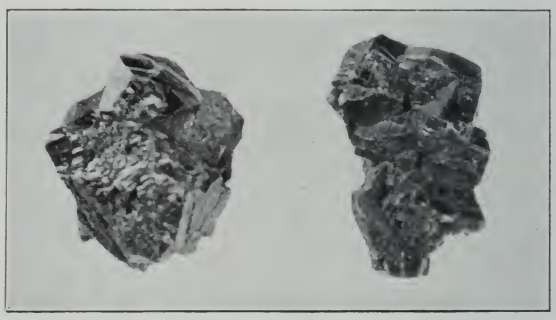

FIG. 19. Sphalerite crystals found in Illinois.

can be scratched with a knife. It is found scattered in most of the limestone formations in the State as is galena with which it is associated in the mining districts in northwestern and southern Illinois. The only sphalerite now produced in Illinois is obtained as a by-product of fluorspar mining.

Rocks

The three great classes and the principal types of rock in each class have been pointed out (p. 21). There are many additional less common or unique types, an almost complete series of transitional types, and a large number of varieties of many of the types. Examples of the types and of many of the varieties may be found more or less commonly in the glacial drift in Illinois. Only the principal types most commonly found are discussed in this manual.

IGNEOUS ROCKS

The two great divisions of igneous rocks have been mentioned (p. 21). The principal types of igneous rocks can be simply and conveniently classified as shown in the following table:

	Generally light colored, feldspar dominant		Generally dark colored, ferromagnesian minerals dominant	
	With quartz	Without quartz	With feldspar	Without feldspar
Granular	Granite	Syenite	Dolerite	Peridotite
Dense	Felsite		Basalt	

As syenite and felsite are not very commonly found in Illinois, they are not described in detail below as are the others.

Granite is probably the most common igneous rock found in the glacial drift or along streams in Illinois. It is an intrusive rock composed principally of feldspar and quartz with minor amounts of hornblende, pyroxene, and

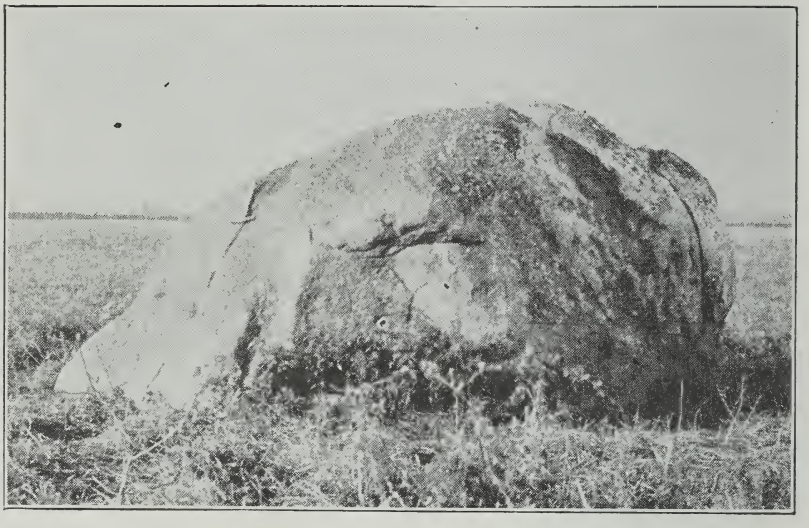

FIG. 20. A granite boulder near Kankakee, Illinois.

mica, each of which can usually be distinguished as granite is always finely to coarsely granular. It is usually gray or pink, but some granites are red, black, or mottled, depending on the color of the dominant minerals. **Syenite** is similar to granite and differs only in that it contains little or no quartz. Granite is used for building and monumental stone, and in Illinois granite and syenite boulders from the drift are used locally in masonary and rock gardens.

Dolerite, which also occurs commonly in Illinois as boulders in glacial drift, is an intrusive rock composed principally of ferromagnesian minerals with minor amounts of quartz and feldspar. Consequently it is generally dark gray or almost black. Dolerite is divided into two subtypes, **diorite** and **gabbro,** depending on

FIG. 21. A hand specimen of light gray diorite.

whether the ferromagnesian minerals are hornblende or pyroxene, respectively. In coarsely granular dolerite the minerals can be sometimes distinguished so that the subtype can be identified, but in finer grained dolerite the minerals can be distinguished and the subtype thereby identified only with the aid of a microscope. Commonly dolerite is locally termed gray, dark, or black granite. The dolerite boulders in the glacial drift in Illinois are used locally in masonry and rock gardens.

Peridotite, the only type of igneous rock exposed in Illinois (Hardin County), is a dark intrusive rock that occurs as vertical walls (*dikes*) or horizontal sheets (*sills*) in other rocks. It is composed of pyroxene, hornblende, mica, and other dark minerals, with little or no quartz and feldspar. At some places it is sufficiently

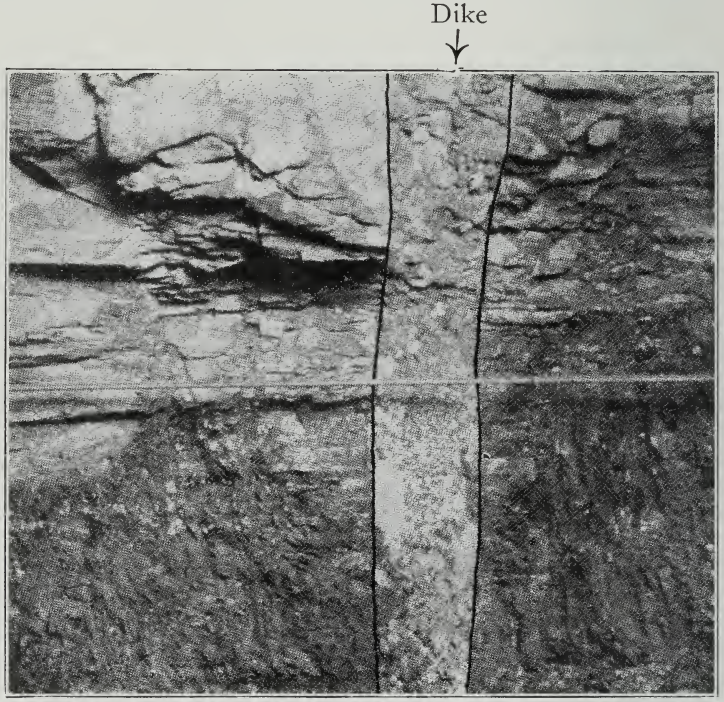

FIG. 22. Peridotite dike in a coal mine in southern Illinois (Pope County). *Illinois State Geol. Survey Educational Series No. 1, fig. 8.*

coarse to show the individual minerals; at others it is dense and so finely crystalline that it appears to be a mass of a single material. Like dolerite, peridotite is divided into two subtypes, **hornblendite** and **pyroxenite,** depending on which ferromagnesian mineral is dominant, although this distinction can be made usually only with the aid of a microscope.

Basalt is a very dark, dense extrusive igneous rock composed principally of ferromagnesian minerals with minor amounts of feldspar and other minerals in grains so small that they can be seen only with a microscope. It is generally black in color, sometimes with a grayish, greenish, bluish, or purplish tinge and is uniformly dull

FIG. 23. A view of basalt as it occurs in place (New York) showing typical columnar structure. *Courtesy of U. S. Geological Survey.*

in appearance. In contrast to basalt, **felsite,** the other principal extrusive igneous rock, is light colored, flinty in appearance, and consists dominantly of feldspar and quartz with minor amounts of ferromagnesian minerals. Boulders of basalt are not uncommon in the glacial drift in Illinois and are used locally in masonry and rock gardens.

Porphyry is a type of igneous rock distinguished by its texture rather than by its mineral content as are the other types. It consists of larger crystals or *phenocrysts* of mineral embedded in a dense or granular *groundmass* of finer crystals. There are as many varieties of porphyries as there are possible combinations of rock minerals and igneous rock types. A type probably most commonly

Fig. 24. A hand specimen of porphyry.

found in Illinois and occurring as boulders in the glacial drift consists of quartz crystals embedded in a red groundmass composed dominantly of feldspar. Garnet and feldspar porphyries are also common and other types occasionally occur also as boulders in the glacial drift. They are used locally in masonry and rock gardens; the red quartz-feldspar variety is especially attractive and is much desired.

METAMORPHIC ROCKS

As metamorphic rocks are derived from igneous and sedimentary rocks and as there are all degrees and modes of metamorphism it is apparent that there are innumerable types and varieties of metamorphic rocks. However, there are several main types, of which only three are sufficiently common in the glacial drift in Illinois to deserve especial attention in this manual.

Gneiss (pronounced "nice") and **schist** are two closely related types of metamorphic rocks which in some cases are intergradational. Gneiss has the mineral composition and the general appearance of granite except that

FIG. 25. A boulder of gneiss.

it is distinctly banded. The bands may be regular or irregular, uniform or interrupted, even or bent, twisted, and crumpled. Gneiss may be derived from granite, syenite, or other rocks having a granitic composition and

FIG. 26. Quartzite in place.

texture. Schist is generally more closely and more regularly banded than is gneiss, and it tends to split into uneven plates which are often spangled with flakes of mica. Under certain conditions of metamorphism granitic rocks may give rise to schists instead of gneisses, but the ferromagnesian rocks always give rise to schists. There are numerous varieties of schist depending on the outstanding minerals. Boulders of gneiss and schist are used in local masonry and rock gardens.

Quartzite is a dense metamorphic rock derived from sandstone. It consists of grains of quartz so firmly cemented by quartz that the rock breaks across instead of around them. It is one of the hardest rocks known. It may be white, gray, reddish, purplish, or yellowish in color. Quartzite is used for paving blocks, for bricks to line high-temperature furnaces, for ganister in making fire-resistant brick and in glass work, but in Illinois the boulders in the glacial drift are only used locally in masonry and rock gardens, for which purposes they are highly desirable.

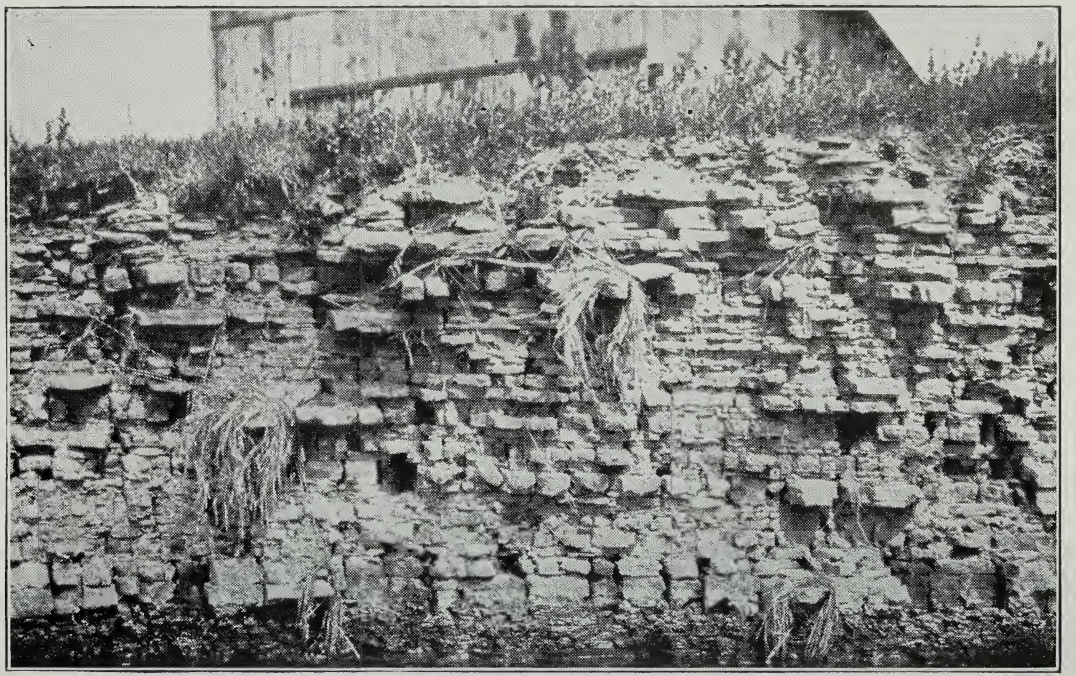

FIG. 27. Thin-bedded limestone near Essex, Kankakee County. *Illinois State Geol. Survey Bulletin 55, fig. 12.*

SEDIMENTARY ROCKS

The principal types of sedimentary rocks have been listed (p. 22). All of these are represented in Illinois, both as bedrock in place and as boulders in the glacial drift.

Limestone and **dolomite,** which are not easily distinguished, together constitute one of the most common and most important sedimentary rocks. Pure limestone consists of calcium carbonate ($CaCO_3$), usually in the form of crystalline calcite; dolomite consists of an intimate mixture of calcium and magnesian carbonates in the proportion of about 54 to 46 and might more properly be called magnesian limestone. Limestone effervesces readily when treated with cold dilute hydrochloric acid; dolomite reacts with the acid only when it is heated or very finely powdered—this difference is commonly employed to distinguish them.

Most limestones and dolomites are not pure but contain different amounts of clay, sand, chert, numerous minerals, and other materials. They are most commonly various tints and shades of gray, buff, or white, sometimes with bluish, yellowish, or pinkish cast, but they may be almost any color. The yellow, red, and brown colors are due to iron oxide and the dark colors are due to organic material in the rock.

In some limestones and dolomites the carbonates are in crystals sufficiently large to be seen and to reflect light so that the surface of the rock glistens. In others the mineral grains are so small or so mixed with clay that the rock is uniformly dense and dull or powdery in appearance.

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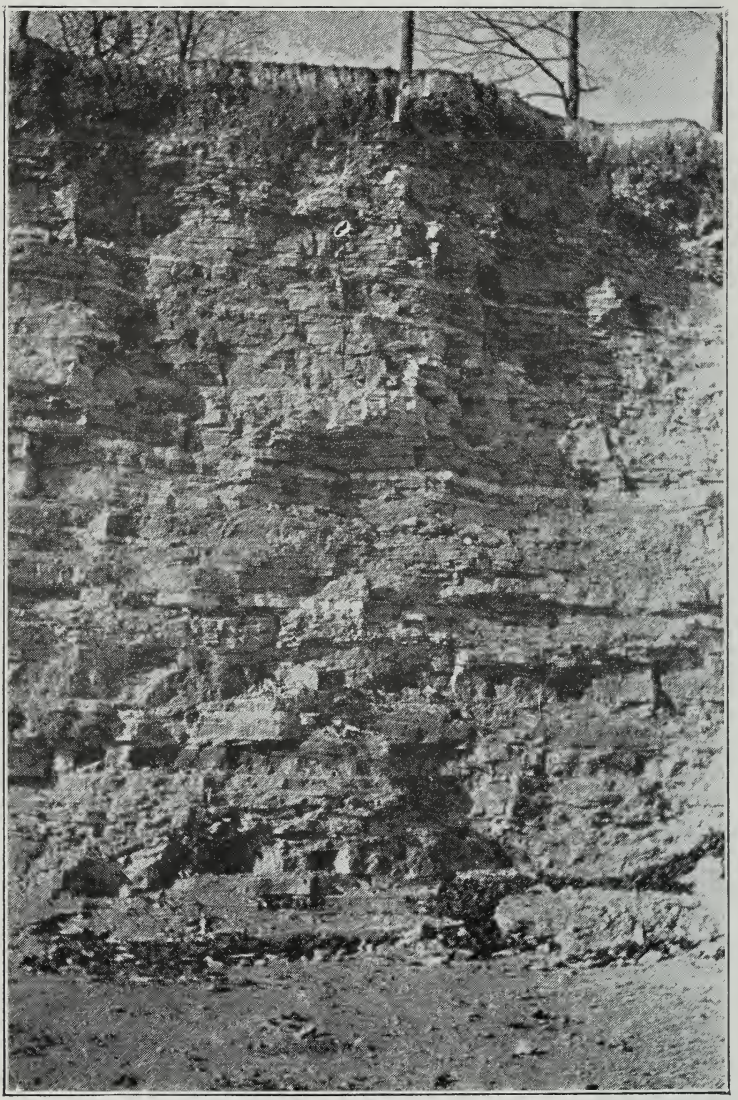


FIG. 28. Cherty Shakopee dolomite as exposed in a quarry near Franklin Grove, Lee County.

Most limestones have been formed by the consolidation of calcareous material that was deposited in the sea either as a lime mud or as a precipitate from the water under favorable physical and chemical conditions with or without the assistance of animal and bacterial agencies. It is believed that most dolomite has been derived from limestone in which part of the calcium carbonate has been replaced by magnesium carbonate either at the same time or after the calcareous material was deposited. Remains of the animals that existed at the time were commonly included in the sediments and were subsequently petrified, that is, partly or wholly replaced by mineral substances, so that they were preserved as fossils. Most limestones generally contain fossils in more or less abundance and some consist largely of them.

Most of the material settled on the bottom of the sea where it formed relatively flat-lying beds, but at some places coral reefs similar to the present-day coral reefs in tropical regions were built up by the animal life, and at other places deposits of shells accumulated along beaches as they do at the present time. A few limestones have been formed by the consolidation of calcareous material deposited on land or in fresh water. The origin of the various kinds of limestone can be determined by their character, their mineral content, and by the fossils in them.

Limestone and dolomite are used for many purposes. Stone of uniform texture, free from stains and undesirable constituents, especially pyrite, easily workable, and resistant to weathering is used as building stone. Relatively pure limestone is used as a flux in smelting iron, copper, and other metals, is ground for whiting, and is burned to make lime. Clayey limestone or pure limestone

mixed with clay is used in the manufacture of Portland cement. Various grades of limestone and dolomite are used as aggregate in concrete, as road metal, as railroad ballast, as riprap along river banks and levees, as agricultural limestone to improve the quality of soil, as filter stone in sewage treatment plants, and for numerous other purposes.

Limestone and dolomite suitable for some or all of these purposes are found at various localities in Illinois. More than seventy commercial quarries, mines, and plants utilizing them are located in the State and the value of the quarried rock amounts to about ten million dollars each year. Fragments of limestone and dolomite constitute the major portion of the gravel deposits in the State and in that form the rock has a wide variety of uses and great commercial value.

Shale is also a very common and very important sedimentary rock. It is composed principally of very finely divided rock particles and of soft clay minerals with which may be included variable amounts of coarser rock particles, calcareous or magnesian material, numerous minerals, and organic matter. It may be any color, due to various impurities or minerals, but it is usually gray with bluish or greenish cast. It is generally soft when freshly exposed but is hard and brittle when dry. Most shale weathers readily into soft, plastic clay.

Shale has been formed by the consolidation or induration of clay, to which it is similar. Most clays have been deposited in quiet water, in which the fine particles that compose them had opportunity to settle and accumulate. They may have been deposited either in the sea or in lakes and ponds on land. Due to the conditions of

deposition, clays and shales are laminated or finely layered. Clay also forms the matrix of glacial drift in which coarser materials are distributed.

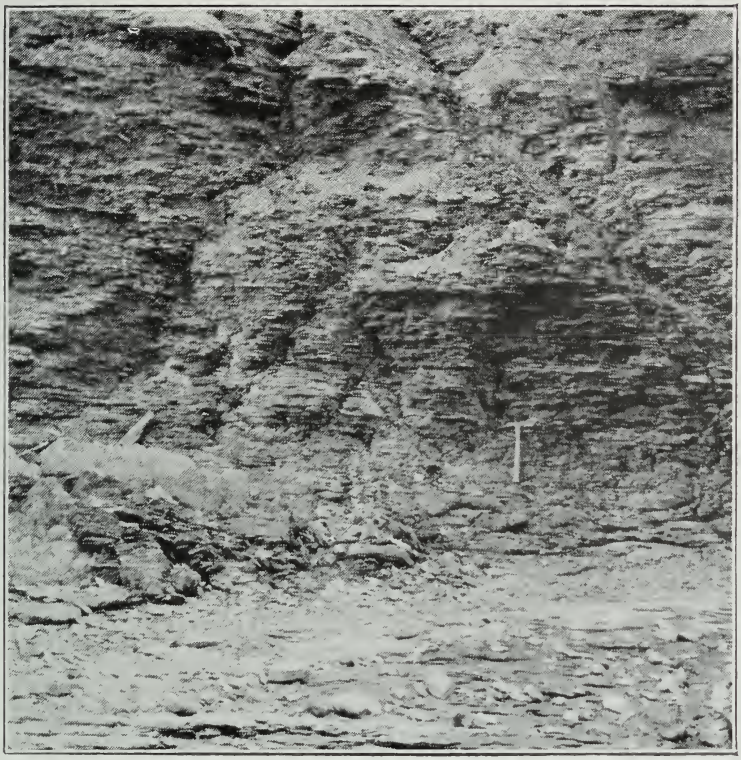


FIG. 29. An outcrop of thinly bedded shale in southern Illinois (Union County). *Photograph by J. E. Lamar.*

Shale and clay are used for making many kinds of brick, tile, pottery, stoneware, chinaware, and many other products. Nearly every variety of clay or shale used in these products occurs in Illinois. There are more than eighty plants in the State utilizing each year shale and clay for products worth nearly thirty-five million dollars.

Sandstone is a common sedimentary rock composed of rock particles of sand size, with which may be associated various amounts of clay, calcium or magnesium carbonate, and other extraneous material. **Siltstone** is similar to sandstone except that it is composed of rock particles of silt size. Sandstone and siltstone are commonly white or light gray in color, but they are frequently

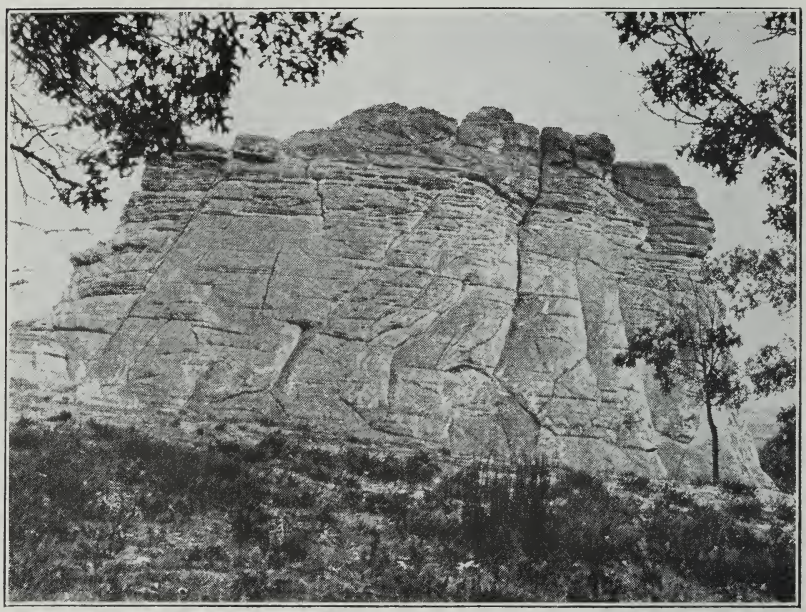


FIG. 30. Sandstone (St. Peter formation) standing as an isolated block near Oregon, Illinois. *Photograph by A. Bevan.*

colored yellow, red, brown, or green as a result of some of the impurities, usually iron compounds, included in them. They have been formed from sand and silt by consolidation or cementation of the grains with silica, iron oxide, clay, calcium or magnesium carbonate, or other material. If poorly cemented they crumble easily.

Sandstone is used for building stone and abrasive stones, and sand produced by crushing it is used for abrasives, steel molding sand, glass, and other products. Sandstone occurs in many places in Illinois, but very little of it except the St. Peter formation is suitable for any useful purpose. More than 2,000,000 tons of high grade sand for abrasives, molding sand, and glass, valued at two and a half million dollars, was obtained in 1928 from the St. Peter sandstone near Ottawa, Illinois. Some of the harder types of sandstone are found in glacial drift.

FIG. 31. Conglomerate (p. 59) from the Pottsville formation in southern Illinois. Four-fifths natural size. *Illinois State Geol. Survey Bulletin 48, fig. 13.*

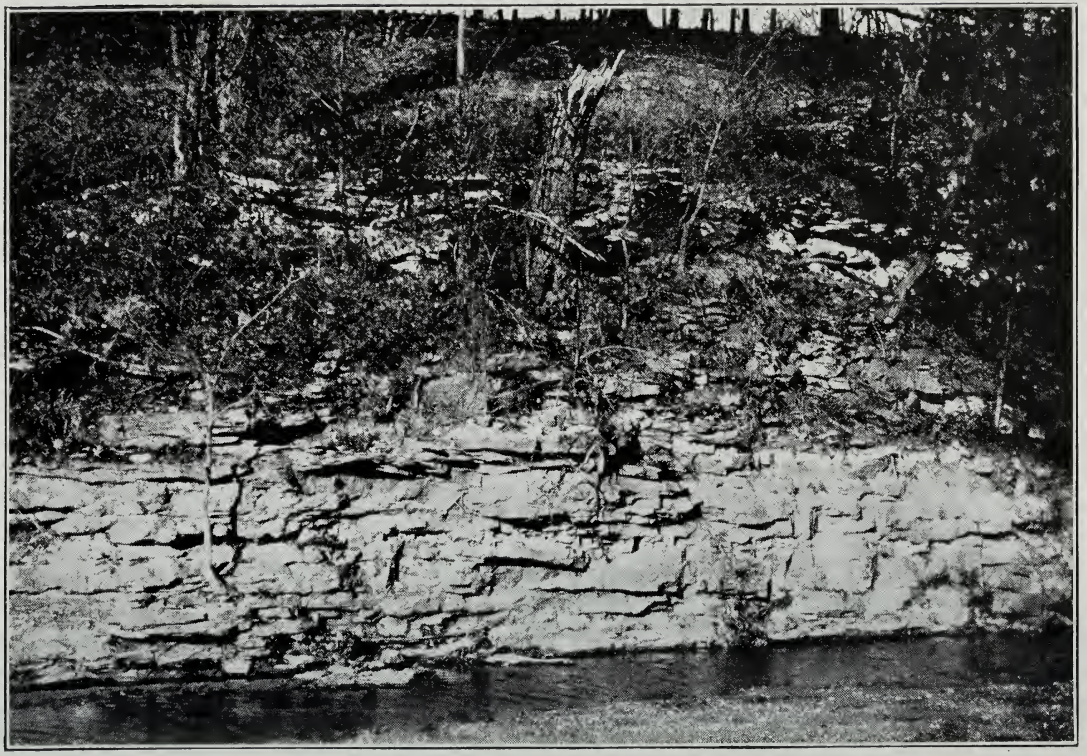


FIG. 32. Bands of white chert in limestone in southern Illinois. *Photograph by A. H. Bell.*

Conglomerate is a sedimentary rock composed of coarse rock fragments held together commonly by a cement of silica, calcium or magnesium carbonate, iron oxide, or other material. The gravel from which the conglomerate was formed was deposited on land, in streams, along beaches, or on the bottom of seas and lakes. Conglomerate if often associated with gravel deposits or sandstone and is frequently found at the base of sandstone formations. It occurs in minor amounts in many places in Illinois, and if not too firmly cemented is crushed locally and used as gravel. (Fig. 31, p. 57.)

Subsidiary rock forms

Mineral or rock material localized in regular or irregular forms is commonly encountered in sedimentary rocks. These masses may be technically considered as rocks, but inasmuch as they (1) appear more or less segregated from the rock in which they occur, (2) frequently occur entirely apart from the rock in which they were originally embedded, and (3) attract attention because of their unique characteristics, they are more conveniently considered as forms subsidiary to the typical rocks. The most common forms that may be thus classified are chert, nodules, concretions of various kinds, geodes, and fossils, and these are described below.

Chert is a rock form composed of extremely finely crystalline silica (SiO_2). The more nearly pure, opaque, gray, or dark colored varieties are commonly known as **flint,** from which savages prepared most of their stone weapons, such as arrow points, knives, etc. Chert is

usually gray or white in color, but not infrequently it is brown, red, black, or blue. It is very hard and breaks with a smooth curved fracture.

Chert is nearly always associated with limestone and dolomite, in which it generally occurs as nodules, lenses, and irregular layers, although some formations are composed almost exclusively of chert. Some of it may have been deposited at the same time as the limestone and dolomite, but much of it has been formed later and either fills cavities dissolved in the rock or replaces some of the rock. Because chert is hard and more resistant to weathering than is limestone, it remains after the limestone or dolomite in which it was originally embedded has been weathered away. For this reason the weathered surface of cherty limestone or dolomite is commonly marked by a concentration of chert, and the beds of streams that flow through areas in which cherty limestone and dolomite occurs contain an abundance of chert gravels.

Chert is known to have only a few uses, among which its use for road metal and similar purposes is the most important. Usually it is considered an undesirable constituent in limestone or dolomite. It occurs more or less abundantly in nearly all of the limestone and dolomite formations in Illinois, and is especially common in some of the limestones and in the stream gravels in western and southern Illinois. It is also common in glacial drift and gravel deposits.

Concretions are more or less symmetrical or irregular rock forms which occur most commonly in shales, clays, sands, and sandstones. They are composed either of distinct minerals or of portions of the parent rock very

firmly cemented by mineral matter. The commonest minerals forming concretions are calcium carbonate ($CaCO_3$), iron carbonate ($FeCO_3$), iron oxides, and silica (SiO_2). The minerals were precipitated around some nucleous and the concretion increased in size as more mineral was deposited.

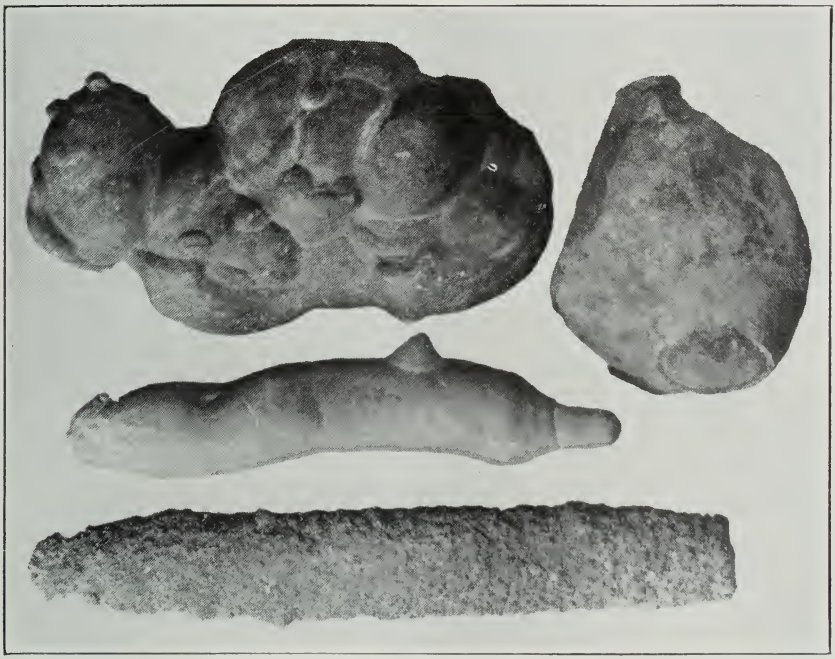


FIG. 33. Concretions of various types found in Illinois.

Parts of plants and animals frequently served as nuclei around which concretions were formed. Large concretions of "iron-stone," known as "niggerheads," are commonly found in the shales associated with the coal beds in Illinois, and small irregular concretions of calcium carbonate, called "kindchen," are common in glacial drift and in loess (fig. 7, p. 20).

Geodes are bodies of mineral matter rudely spherical in shape and generally hollow. The outer shell is usually composed of chalcedony, a form of finely crystalline silica, which is lined with crystals of calcite, quartz, sphalerite, and other minerals which may fill the geode entirely.

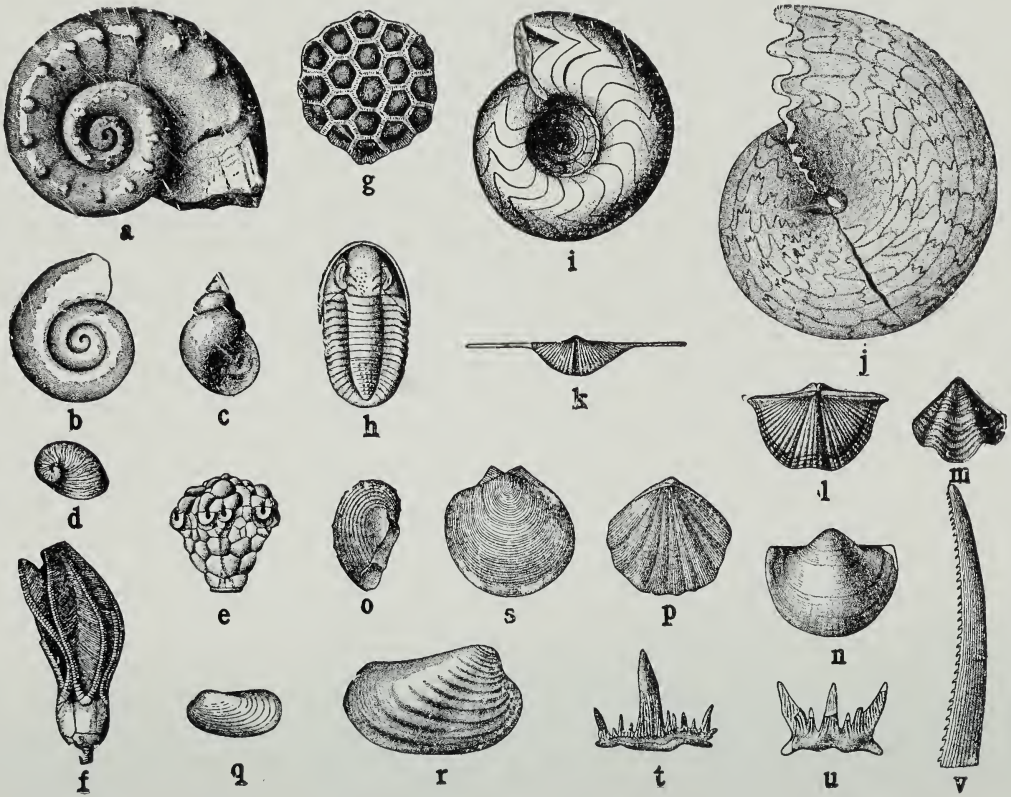
FIG. 34. A geode broken open to show the quartz crystals that line it, and the large calcite crystals that occur in it. *Courtesy Illinois State Museum, Springfield.*

Geodes are commonly associated with limestone and dolomite and sometimes with shale or sandstone. They differ from concretions in that they are typically hollow whereas concretions are solid, this difference being the result of the fact that concretions grew from the center outward whereas the geodes grew from the outer shell inward.

Fossils are the petrified remains of animals and plants and other evidences, including tracks, imprints, etc., of their existence. They are usually composed of calcite or silica and less frequently of pyrite, phosphatic minerals or other substances. They are found in all classes of sedimentary rocks, and are especially common in limestone, dolomites, and shales, although some formations may be barren of them. As the animals whose remains are fossilized must have lived and died while the sediments in which they are preserved were being deposited, they indicate the types of life and the climatic conditions that existed at those times. Examination of the fossils contained in the various rock formations has revealed that each formation is characterized by certain fossils or groups of fossils which occur in no other formation, and which are therefore "index" fossils and serve to identify the formation wherever it occurs. A study of the fossils found in successively younger formations also provides the data by which the development of life forms may be traced throughout geologic time. Consequently fossils are objects not only interesting but also highly valuable to science.

Fossils representing thousands of species and varieties of animals and plants occur in the sedimentary rocks in Illinois, but they can all be grouped in a few large orders, as follows:

(1) *Corals* are small invertebrate (without a backbone) sea animals, low in the life scale, which live in warm seas from which they extract calcium carbonate to build their stony exterior skeletons. They may be individual "cup" or "horn" corals or they may be colonial, in which



LEGEND

a, b, c, d : gastropods

e, f : crinoids

g : coral

h : trilobite

i, j : cephalopods

k, l, m, n, o, p : brachiopods

q, r, s : pelecypods

t, u : shark's teeth

v : shark's spine

FIG. 35. A group of typical fossils found in Illinois. *(After Chamberlin, T. C., and Salisbury, R. D., Geology, vol. II. By permission of Henry Holt & Company, publishers.)*

case they build up masses or reefs of "coral trees," "brain coral," "honeycomb coral," "bee-hive coral," "pipe-organ coral," etc. (Fig. 35, g.)

(2) *Blastoids,* commonly known as "Indian flowers" or petrified "hickory nuts," are invertebrate sea animals that lived in bud-shaped receptacles attached to the ocean bottom by stalks. Five grooves separated the "bud" into "petals," which appearance is responsible for their local name.

(3) *Crinoids,* commonly called "sea-lilies," are invertebrate sea animals that lived in flower-like receptacles attached to the ocean bottom by long stems. The stems are composed of short, button-like segments of which the fossils are commonly known as "Indian beads" or "St. Jacob's beads." (Fig. 35, e, f.)

(4) *Brachiopods,* of which the "lamp-shell" is a modern representative, are invertebrate sea animals. They have two shells which are different one from the other but which are bilaterally symmetrical. They are probably the most common fossil form. (Fig. 35, k-p.)

(5) *Bryozoa* are tiny invertebrate animals related to brachiopods in body structure but living in colonies like colonial corals. The calcitic structures in which they live appear like branching plants, stems, leaves, ferns, mosses, lichens, sea-weed, etc. Each member of the colony occupies a tiny cell in the structure.

(6) *Pelecypods,* of which mussels, clams, scallops, and oysters are modern representatives, are invertebrate animals that have two shells congruently symmetrical (mirror reflections of each other) but otherwise not symmetrical. Fossil pelecypods are common, especially in shales. (Fig. 35, q, r, s.)

(7) *Gastropods,* of which snails and slugs are modern representatives, are invertebrate animals that have a single shell, usually coiled and conical, and completely occupied by the animal. Fossil gastropods are relatively common and are especially abundant in the loess and sand associated with glacial drift. (Fig. 35, a-d.)

FIG. 36. Reconstruction of swamp forest in Pennsylvanian time. *After H. Potonie.*

(8) *Cephalopods,* represented in modern times by the chambered nautilus, are inverterbrate sea animals that have a single shell, which may be either straight or more or less coiled in a single plane, thus differing from gastropods. The shell is composed of several chambers of which only the outermost one is occupied by the animal, in which respect cephalopods also differ from gastropods. (Fig. 35, i, j.)

(9) *Trilobites* were sea animals that resembled the modern crabs, crayfish, and lobsters. (Fig. 35, h.)

(10) *Vertebrates,* or animals with backbones, are represented in fossil form in Illinois rocks by sharks' teeth and spines (fig. 35, t, u, v) and by an occasional fish.

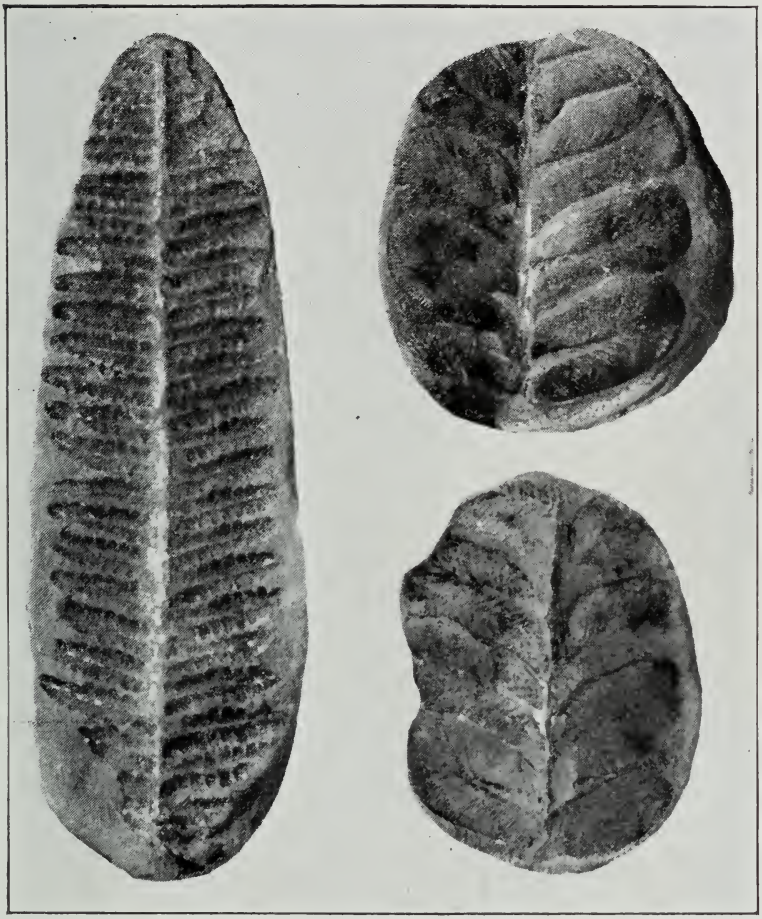


Fig. 37. Fossilized impressions of plant leaves as preserved in concretions.

Bones and other skeletal parts of animals are found in the glacial drift or in alluvial deposits.

(11) *Plants,* usually gigantic types of the fern and moss families (fig. 36), grew luxuriantly at certain stages

in geologic time. Large accumulations of them formed the mass from which the coal beds are derived. Fragments of plants are scattered through the rocks associated with the coal beds (fig. 37).

Natural Mineral Products

In addition to the mineral products which have been described under the classifications of minerals, rocks, and rock forms, there are other materials derived from the earth which can not be classified either as minerals or rocks or which are only commercial varieties of regular minerals and rocks. These may be conveniently considered as mineral products and as such are described below.

Peat is a compressed mass of matted vegetation that has accumulated in marshes and swamps where the waters have preserved it from decay. It may be mixed with clay, and silt. When fresh it is light brown or straw-yellow in color, but as it grows older it becomes darker. After it is cut and dried it may be used as a low grade of fuel. It is also used as an absorbent, as stock feed, as litter, as an insulating or packing material, and as fertilizer.

Peat in greater or smaller amounts occurs in many places in Illinois. It fills old swamps, ponds, and lakes in the glacial drift in northeastern Illinois; it fills depressions and abandoned channels in the valley bottoms along many rivers and streams everywhere in the State; deposits formed on the surface of one glacial drift are found buried beneath a younger drift. It is but little exploited.

Coal is a carbonized form of plant material. It has been derived from peat by physico-chemical processes operating through a long period of time. Various im-

purities, such as clay or shale, limestone, pyrite, etc., are common in it. There are various grades of coal depending on the degree of coalification which it may have undergone. All coal in Illinois is *bituminous* or "soft" coal. It breaks fairly easily into irregular blocks and fragments and has a relatively bright luster. *Anthracite* or "hard" coal breaks with a curved fracture and has a very bright lustre.

FIG. 38. An outcrop of coal along a stream in western Illinois. *Photograph by H. R. Wanless.*

Coal is very important as fuel. Gas, coke, and coal tar are produced by partial combustion of coal. Dyes, perfumes, artificial extracts, tar-like compounds, drugs, disinfectants, preservatives, and other products are derived from coal tar. Gasoline may be distilled from coal.

Workable beds of coal underlie about two-thirds of the State. There are about 175 commercial mines in the State, some of which are the world's largest, most modernly equipped coal mines. There are also about 700 private or local mines. The mines produce each year from 50 to 60 million tons of coal, valued at about 120 million dollars.

Petroleum or "rock oil" is a liquid mixture of hydrocarbons, in which various impurities, such as sulfur, may occur and with which natural gas is frequently associated. It varies greatly in composition and ranges from yellow through green and brown to black in color. It is generally agreed that petroleum and natural gas has been derived from organic material in the rocks and that they accumulate in porous rock underlain and overlain by impervious rock strata. They are obtained by penetrating the oil-bearing strata with wells.

Gasoline, kerosene, naphtha, vaseline, lubricating and medicinal oils, greases, salves, heavy fuel and road oils, tars, asphalt, and many other products are derived from petroleum. Most of the petroleum in Illinois is produced in the southeastern part of the state, but small oil fields have been found in the southern and western parts.

Silica sand is the commercial designation for sand that consists almost or entirely of quartz or silica. It is used for the manufacture of high grade glass, for which purpose very pure silica sand is required, as the slightest impurities affect the quality of the glass; also as steel molding sand, refractory sand, engine sand, abrasive sand, and in the manufacture of "water glass" (sodium silicate). It is finely pulverized and used in the manufacture of scouring soaps and pastes, grinding and polishing powders,

mold facings, glazes, alloys, and as a mineral filler, etc. A very carefully screened coarse sand from Ottawa, Illinois,

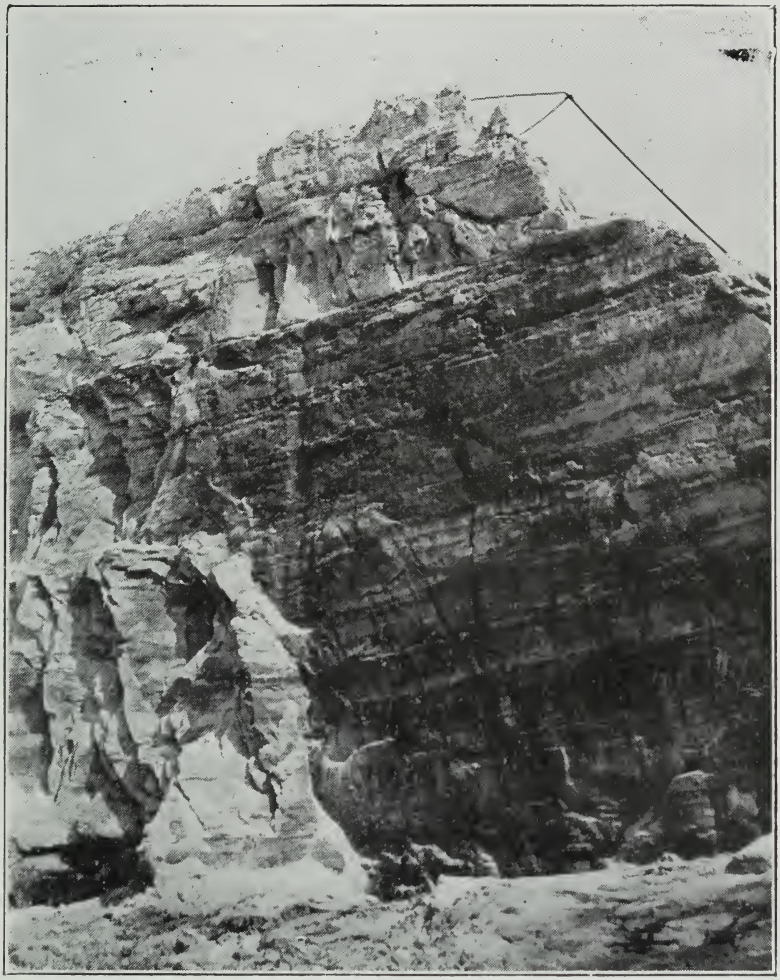


FIG. 39. Face of a silica sand quarry at Wedron, Illinois. *Illinois State Geol. Survey Bulletin 53, fig. 6.*

known as Standard Ottawa Testing Sand, is employed in testing cement and mortar and for many experimental purposes.

Silica sand is produced from the St. Peter sandstone in the vicinity of Ottawa, Illinois, where more than 2½ million tons, valued at almost as many dollars, were produced in 1928.

Common molding sand consists of medium or fine sand mixed naturally or artificially with sufficient clay or iron oxide to give bond to the entire material. It is generally yellowish-brown to dark brown, due to the iron oxide present, and is used to form molds in which metal castings are made.

Good molding sand occurs at various places in Illinois. Most of it has been developed by the weathering of sand deposited by glacial waters, so that only the upper portions of most sand deposits are suitable for use as molding sand. The loess is also a source of molding sand. Common molding sand valued at more than two hundred thousand dollars is produced in Illinois each year.

Tripoli or "silica" as it is often called, is a white powdery form of silica that is developed by the decomposition of chert. It is mined and ground into a flour-like

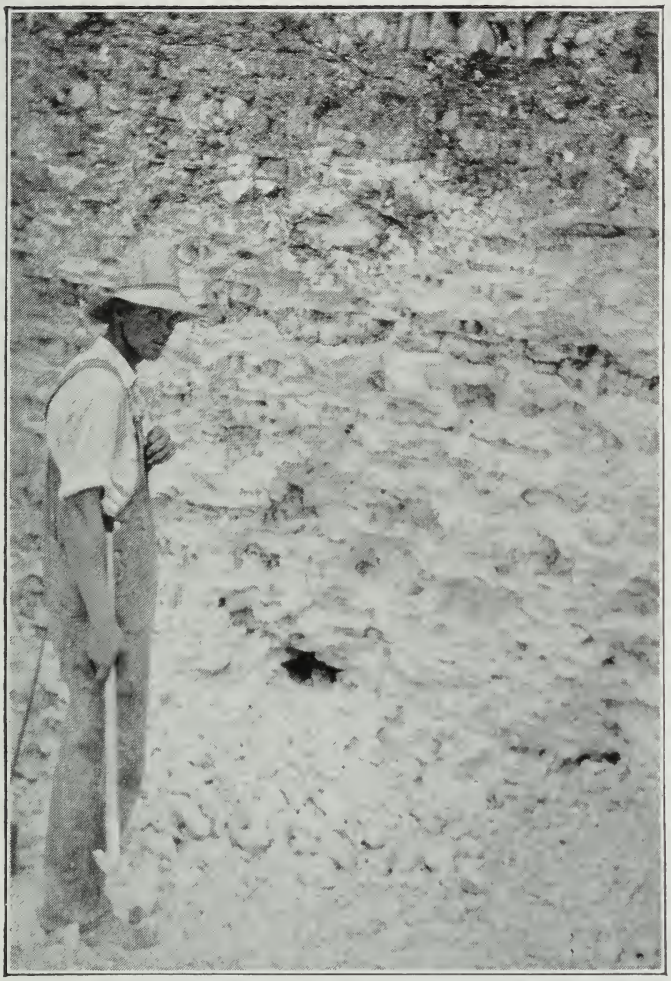


FIG. 40. Exposed face of a tripoli mine near Elco, Union County, Illinois. *Photograph by J. E. Lamar.*

powder, in which form it is used in polishing and buffing preparations, scouring soaps, as a mold wash, and as a mineral filler. It occurs in Alexander and Union counties, Illinois, where it is being mined and milled.

FIG. 41. Fullers' earth as exposed in a pit in southern Illinois. *Illinois State Geol. Survey Report of Investigations No. 15, fig. 5.*

Fullers' earth is a unique variety of clay which is capable of absorbing basic colors from oils. It was originally used for fulling or removing grease from cloth but now it is used in large amounts for bleaching and clarifying fats, greases, and oils, especially petroleum, and as a detector of coloring matter in food products. It occurs in Illinois only in Pulaski County, where it is being commercially produced.

Ocher is commonly described as a soft powdery form of yellow or brownish-yellow iron oxides, usually containing some clay and sand. Savages utilize it as the source of many of their paints. It is used as paint pigment, as mortar color, and as a filler in linoleum and oil cloth. Ocher occurs at several places in southern Illinois, but it is not expoited in any notable amount.

GLOSSARY

Abrasives—materials, such as carborundum, emory, sand, and hard powders, used for sharpening, cutting, grinding, drilling, cleaning, polishing, and similar purposes.

Calcareous—containing calcium carbonate.

Climatic changes—marked changes in climate, usually applied to seasonal variations or changes over long periods of time.

Consolidation—as applied to rocks, the development of hard rock from loose material by one or more processes, such as simple compaction or pressing together, chemical changes in the materials themselves, cementation by any of several minerals deposited by ground-water, or introduced through volcanic agencies, alteration as result of tremendous heat, stresses, and pressures exerted by earth movemnts and volcanic action, etc.

Crystal—the regular or normal form that a mineral will assume if free to do so when it changes from a gas or a liquid to a solid. There are seven different systems of crystals, and in each system there are a large number of possible combinations of the faces bounding the solid. The crystals of each mineral always have their own characteristic forms.

Effervescence—a boiling and hissing effect resulting from bubbles of escaping gas formed by rapid chemical reactions.

Erosion—literally "wearing away"; in geology, the term is applied to the wearing down of the earth's surface by processes of nature.

Ferromagnesian—containing iron (ferrum in Latin) and magnesium.

Flux—a substance added to any ore to make it melt and flow easily, and to help separate impurities from the metal being smelted or refined.

Ganister—ground quartz sand or silica.

Glaciation—the work of glaciers or the occurrence of widespread glaciers.

Ground water—the water that exists *in* the ground.

Heterogeneous—without any sort of order, regularity, or proportion.

Hornblende and pyroxene—two types of dark minerals composed principally of ferromagnesian aluminum silicates (iron, magnesium, aluminum, and silicon oxides) with which there are lesser amounts of other minerals, such as sodium, calcium, potassium, and manganese oxides. The two types are very similar but can be differentiated by the fact that pyroxenes tend to spilt in two directions nearly at right angles to each other, whereas hornblendes tend to split in two directions at angles of about 60 and 120 degrees with each other.

Hydrous—containing water; applied to minerals in which water enters into their composition.

Impervious—practically proof against the passage of liquid, especially water.

Induration—similar to consolidation.

Inorganic—pertaining to objects and processes related to neither animals nor plants.

Lava—molten rock forced out *on* the surface of the earth through craters of volcanoes or other fissures.

Leaching—the removal of calcium or other specific chemical elements by means of the dissolving action of water passing through the material in which the element exists.

Magma—molten rock *below* the surface of the earth. Compare lava.

Nodules—small nodes or knots of material, either regular or irregular in shape.

Octahedron—a solid geometrical form enclosed or bounded by eight triangular faces; it may be likened to two four-sided pyramids placed with their bases together.

Organic—pertaining to living objects, either animals or plants; organic secretions are materials prepared by the living objects for their own use in some way. Shells are an outstanding example of organic secretions.

Petrified—changed to stone; generally applied to organic remains which are preserved in the form of mineral material.

Precipitate—the solid material that settles out from a mixture of solid and liquid material.

Pyroxene—see hornblende.

Refraction—the bending of a ray or beam of light as it passes through certain substances, such as water.

Residual—remaining in place.

Resinous—having the appearance of resin, which is the hardened sap of certain trees and plants, such as pine trees.

Rhombohedron—a solid geometrical form enclosed or bounded by six rhombic faces.

Riprap—coarse stone fragments laid more or less regularly on the surface of an earth dam, levee, or bank to prevent it from being worn away by flood waters or currents.

Specific gravity—the ratio between the weight of any material and the weight of an equal volume of water; for instance, a material has a specific gravity of 2 if a cubic foot of it weighs twice as much as a cubic foot of water.

Stalactites and stalagmites—accumulations of mineral matter deposited from ground water dripping in caves or other cavities; those that hang from the roof are stalactites, those that are built up from the floor are stalagmites.

Streak—the colored mark made by a mineral when it is drawn across a piece of rough porcelain or some similar material.

Till—the heterogeneous mixture of clay and all sizes of larger rock fragments carried in a glacier and deposited in place when the glacier melts.

Vitreous—glassy, glass-like.

Volcanic—pertaining to volcanoes; volcanic rocks include all those that are formed from the material erupted by volcanoes.

Weathering—the sum result of all natural processes affecting rocks and minerals.

Whiting—the white mineral material used in whitewash, calcimine, and other coarse paint materials.

NOTE TO TEACHERS

In 1917, by legislative enactment, the State Geological Survey was placed under the control of the Board of Natural Resources and Conservation, in the State Department of Registration and Education. The functions of the Survey continued as they had been for many years —gathering basic scientific data in the fields of geology essential to the industrial and educational advancement of the State. The offices and laboratories of the State Geological Survey are located at Urbana on the campus of the University of Illinois.

From time to time, reports of a technical nature are issued which provide a permanent source of information for mining, engineering, and manufacturing. Recently an educational series was inaugurated, of which this number is the third, to furnish authoritative information for the schools and the general public. Suggestions from teachers are requested with a view of making this series of the greatest usefulness.

Copies of this bulletin may be secured by individuals at ten cents each by addressing The Chief, State Geological Survey, Urbana; likewise the first and second numbers, "The Story of the Geologic Making of Southern Illinois," by Stuart Weller, and "The Rock River Country of Northern Illinois," by Deette Rolfe. A reasonable number are furnished to public schools without charge except carriage expense.